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Design of Devices Used in the Study of Stress-Strain-Time Properties

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It is shown that a number of stress-strain devices control the rate of increase of the total load applied to the specimen, but that none takes account of the diminishing cross section as extension proceeds. It is shown how this may be done, thus providing a constant rate of stress increase, by means of a cam which introduces a variable lever arm through which the load is applied.

In the case of extension-versus-time curves, it is important to run the experiment at constant stress rather than at constant total load. A simple means of loading a specimen to accomplish this is described.

THE number of different instruments which have been constructed and used in obtaining stress-strain curves on yarns and fibers is almost as large as the number of investigators thereof, for each one finds some changes suitable to his particular needs. In reviewing these devices, it becomes apparent that the differences are in the particular mechanical means of accomplishing operations, and that they may all be placed in a very few general classes, according to their manner of calling up and revealing the intrinsic properties of the material. Indeed, it has long been recognized that a parameter, such as a modulus, a breaking load, or an inflection point on a stress-strain curve, depends not only upon the material itself but also upon the rate of loading or rate of extension used. Thus, the use of dissimilar machines leads to varying results for the same material. One class of devices extends the material at a constant rate, allowing the retractive force to be the dependent variable. Another class holds the rate of loading of the specimen at a constant value, the extension of the sample assuming values dictated by the material. Still another class makes use of a pendulum type of loading, in which neither of these variables is held constant. In the operation of the last type, while one end of the specimen is extended at a constant rate, the other end acts to raise the pendulum; thus, both the loading and the extension rates are functions of the properties of the material.

While the results obtained by applying a constant rate of extension may be used in connection

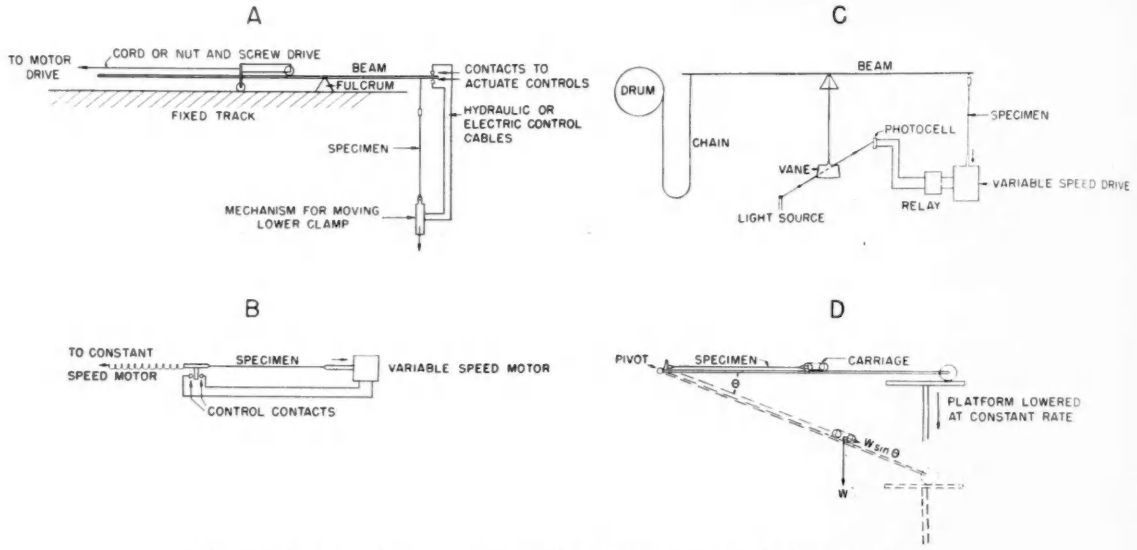

FIG. 1. *Schematic arrangement of various stress-strain dynamometers.*

with the theories of mechanical deformation and its relation to structure, results obtained from the other two types of operations are not suitable for this purpose. This is true because the mathematics of these theories can be made to yield predictions subject to experiment when the stress, or load per unit area, is made to increase at a constant rate, or is held constant. The load per unit area, not the total load, is the significant quantity when dealing with extensible materials.

Methods of Deformation

To extend the specimen at a constant rate, it is necessary to extend only one end by a constant-speed motor and to measure the force developed at the other end with a stress gage. This gage must be one which indicates the force with negligibly small displacements, a condition which pendulum-type machines do not usually fulfill.

No attempt is made in this paper to list completely all the devices described in the literature, and the omission of any particular device is not to be taken as an indictment of its merits. As representative of constant-rate-of-extension devices may be cited those of Denham and Lonsdale [1], of Polanyi [2], and of Sookne and Rutherford [3].

To achieve a constant rate of loading (but not accounting for cross-section changes), a wide variety of methods have been proposed. The simplest of these is a container or cup attached to the lower end of the specimen, the top end of which is fixed. Lead shot or water is then poured into the cup at a constant rate, and the drop of the lower end is recorded. Elaborations of this idea for automatically recording the load-extension curve have been described by Matthew [4], and by New [5].

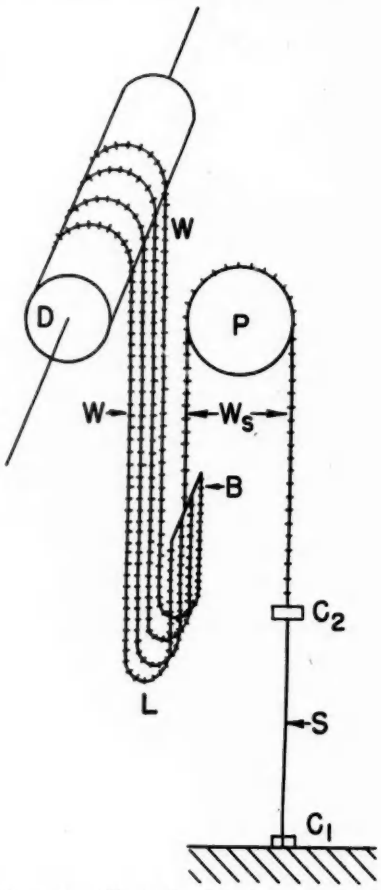

FIG. 2. *Chain load independent of specimen extension.*

In the apparatus of Denison and Lenton [6], the constant increase of load is achieved by having a carriage move at constant speed along a pivoted beam. The method is shown schematically in Figure 1A. The specimen, which is attached to the other end of the beam, is extended at whatever rate is nec-

essary in order to keep the force on the material equal to that produced by the moving carriage. This is done by keeping the beam balanced in the horizontal position by means of contacts or stops which form the contacts of an electric or hydraulic circuit. The driving mechanism which extends the specimen is controlled through these contacts. This principle of loading one end of the specimen uniformly and extending the other so as to keep the first end at the same position is common to a number of instruments. Thus, the apparatus of Barker and Tunstall [7], shown schematically in Figure 1B, applies the load by a spring extended at a constant rate.

The above-mentioned device of Sookne and Rutherford [3] employs, as some other earlier devices do, a balance beam and pointer, the beam being controlled to a balance by photoelectric means which are responsive to the movement of the pointer (Figure 1C). For constant rate of loading, the chain is fed out uniformly, while the fiber is extended to the amount necessary to keep the balance of forces. A similar device is described in British Patent No. 257,634 (Metal Working Company of Ettlingen, Germany), the balance control being operated by contacts on the beam.

A device of quite different principle is the inclined-plane tester. As shown in Figure 1D, the plane upon which the carriage rides is tilted down by the lowering of the platform. The specimen connects the carriage and a fixed clamp, and thus the component of the carriage weight $W_c \sin \theta$ is applied to the specimen. A uniform rate of lowering of the platform results in a uniform increase in $W_c \sin \theta$, thus producing the desired steady rate of loading. A more detailed analysis is given by Shiefer and Cleveland [8]. This device has the advantage that the extension of the specimen does not need to be mechanically regulated, as in the other cases, but may assume any value.

The same advantage and function can also be achieved by the device shown in Figure 2. The load is applied by the chain (or set of chains) W, which is unreeled from the drum at a constant rate. The chain W_s, which passes over the pulley P, has a weight per unit length one-fourth of the chain (or chains) to which it is linked at B. A stretching of the specimen S decreases the length of chain W on the side of the loop L toward the specimen, and thus diminishes the load. For an extension ΔS, the loss in load is $1/2\ W\Delta S$. Since it is desired to

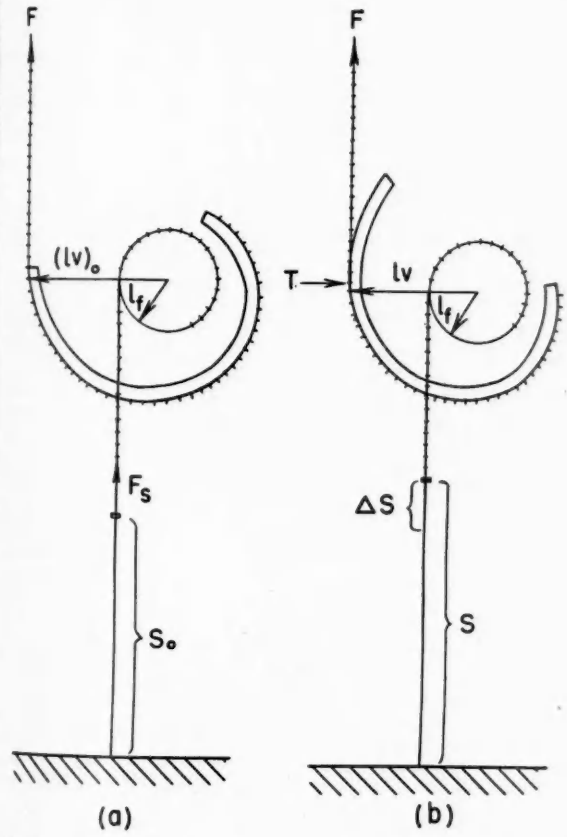

FIG. 3. *Method of making stress independent of specimen extension.*

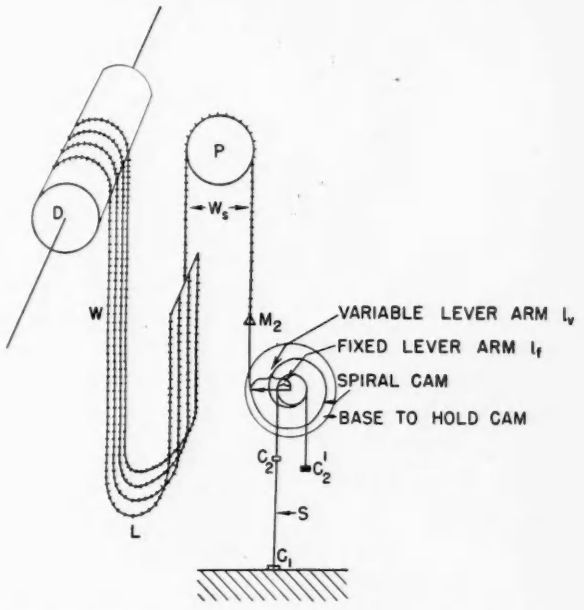

FIG. 4. *Schematic dynamometer producing constant rate of stress increase.*

make the load independent of the specimen length, and determined only by the position of the drum D, this amount $1/2\ W\Delta S$ must be restored. This is done by the movement of chain W_s, a weight $W_s\Delta S$ being taken from the specimen side and added to the other side on pulley P. Thus, $2W_s\Delta S = 1/2\ W\Delta S$, when W consists of four chains similar to W_s or one chain of four times the weight per unit length of W_s.

Constant Rate of Loading Versus Constant Rate of Stress Increase

For any fundamental study of the mechanical properties of materials in which it is desired to make use of the theories of plastic flow and relaxation, the stress or load per unit cross section is the fundamental quantity, and not simply the total load on the specimen. When a material is brittle, and does not diminish appreciably in cross section during a test, then the two quantities run parallel. Similarly, only for brittle materials does a constant rate of loading mean a constant rate of stress increase. For deformable materials such as textile threads, a stress-strain curve has fundamental meaning, and can truly be used to study the intrinsic properties of materials only when the rate of stress increase has been held constant over the whole range of the curve and independent of extension. Several authors have replotted load-extension curves, calculating the cross-sectional area for each value of extension and marking off values on the abscissa in stress units. Such a procedure does not free the resulting curve from the effects of a variable stress rate.

Figure 3 illustrates a principle used in the Kodak Research Laboratories to obtain a constant rate of loading per unit area, regardless of the extensibility characteristics of the specimen. The specimen is seen at its initial length S_o, in Figure 3A. The top end is clamped to a flexible chain or cord which is fastened to a drum of fixed lever arm l_f. A spiral-shaped cam or track is attached to the drum, so that both turn together about the same axis. If a loading device applies a vertical force F to a cord or chain in contact with this cam, the lever arm effective in turning the system has a variable length, denoted by l_v. At the start of the experiment, with specimen length S_o, the force on the specimen is

$$F_s = \frac{F(l_v)_o}{l_f}.$$

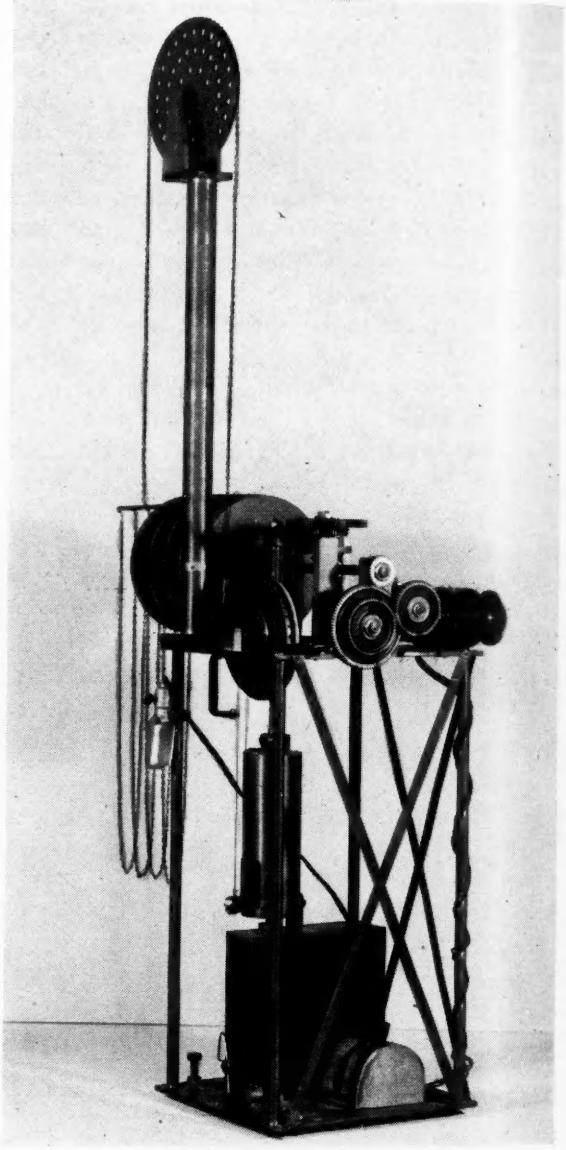

FIG. 5. *Photograph of dynamometer.*

For a fractional extension $\frac{\Delta S}{S}$, as shown in Figure 3B, this force diminishes to $\frac{F \cdot l_v}{l_f}$.

The problem of obtaining constant stress is thus solvable by shaping the cam so that the lever arm l_v and the cross-sectional area diminish at the same rate—that is, when $l_v = \frac{S_o}{S}(l_v)_o$. Figure 4 shows how such a mechanism is used in conjunction with a chain-type constant rate of loading device. Figures 5 and 6 are photographs of such an instru-

ment in use in this laboratory. The graph is recorded by a spark that punctures the paper which is placed around the brass drum. The gearing shown in the illustrations allows the rate of stress increase to be set at any desired value and also permits a previously calibrated graph paper to be used on the drum. The gear settings depend on the cross-sectional area (or denier) of the specimen, which must be determined before running the curve.

The cam drawing is laid out by choosing suitable values of S_o, l_f, and $(l_v)_o$, and scaling out the calculated values of l_v at each increment of rotation. It is desirable to choose S_o, l_f, and $(l_v)_o$ so that, for the extensions to be expected, considerable rotation is obtained and the cam has a gentle pitch. This is necessary because any given point on the horizontal line of the lever l_v, such as point T in Figure 3B, can recede from the vertical line of the chain, as the cam turns an angle θ, by no more than $l_v(1 - \cos\theta)$. A gently receding spiral thus keeps the point of tangency of the vertical chain close to the horizontal lever l_v, and permits the force F_s to be close to the proper value.

This use of a cam to produce a variable lever arm is of course not the only means of holding the rate of stress increase constant. For example, in Figure 1A, the movement of the carriage could be diminished as the specimen extends, by a suitable photoelectric link-up. Also, in Figure 1D, the rate of lowering of the platform could be made to be dependent upon the position of the carriage through photoelectric observation and control.

Extension-Versus-Time Curves

Mechanical properties of films and filaments have also been studied by hanging a fixed load on the specimen, and noting the elongation produced as a function of time. For such curves, the load per unit area is the fundamental quantity and should be held constant for the experiment. Unfortunately, however, the extension-time curves found in the literature have almost universally been run at constant total load or kept to low values of extension. But it is in the range of greater extensions (above 5 percent) that many of the important characteristics of yarns and threads exist.

The importance of maintaining constant stress rather than constant load was recognized by Andrade [9], who devised a hyperbolically shaped weight to be hung on the specimen and allowed to sink into a liquid as the specimen extended. The

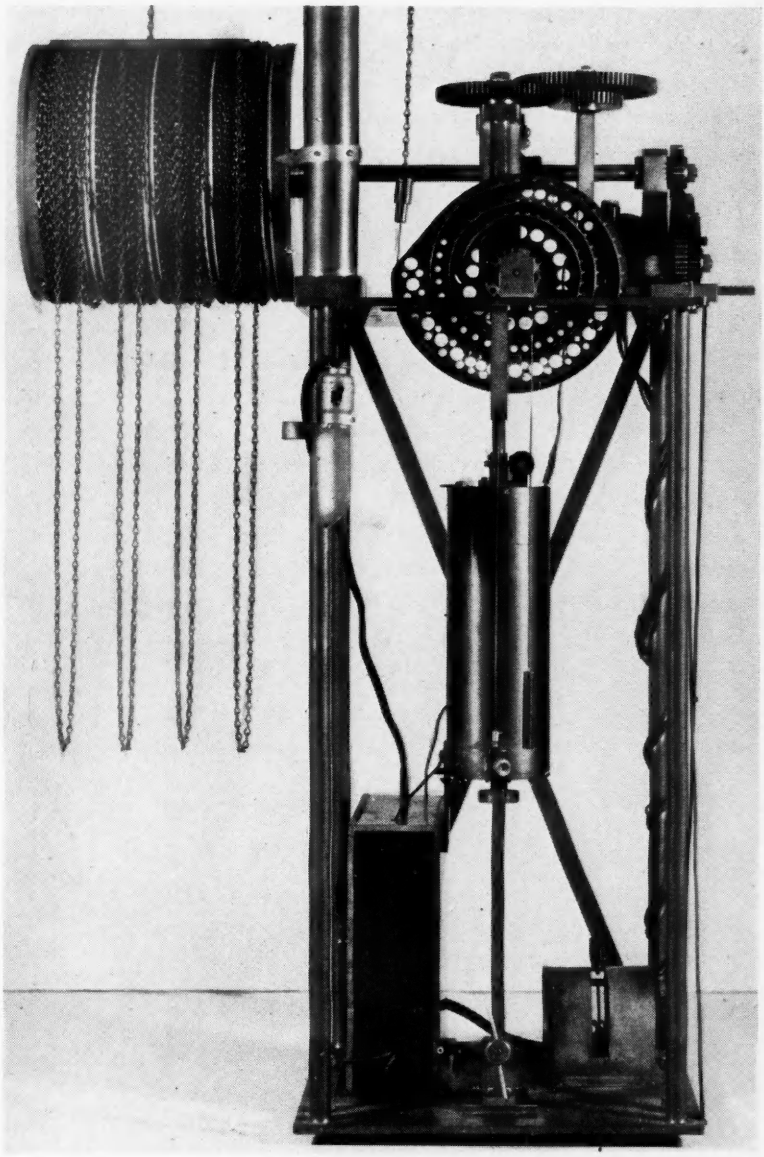

FIG. 6. *Photograph of dynamometer.*

increasing buoyant force compensated for the diminution of cross section. Speakman [10] made use of this device to obtain true extension-time curves on wool. Andrade [11] also devised a variable lever arm balance, a fixed weight being suspended from a cord which passed over a cam-shaped body on one end of a beam. The cam was cut so that as the specimen, attached to the other end of the pivoted beam, extended, the effective lever arm diminished in the ratio of the original to the extended length. The stress-strain dynamometer in Figure 5 is closely related in principle to Andrade's device; a provision on the latter to increase the load at a constant rate would convert it to a similar dynamometer.

Figure 7 shows another method of obtaining extension-versus-time curves at constant stress. Two pegs, P and P', are fastened to a wall, at a distance D apart. (In experiments carried out in this laboratory, D = 100 cm. was found to be a convenient value.) The specimen is fastened to each peg, making the half-length of the specimen equal to $0.65D$. Thus when a load is hung on the midpoint, the specimen and line D form a triangle, as illustrated. The load is applied by a pulley (grooved to fit the type of specimen) which is fitted over a ball bearing, with weights suspended from a shaft through the bearing. The whole assembly, when suspended on the specimen, thus is free to hang from the middle point. As the load drops, its position is noted on a scale as a function of time. To show how this arrangement yields nearly constant stress, it is to be noted that the tension in the yarn or film strip, when the load is first applied, is $T_o = \frac{W}{2 \sin \theta}$. As the specimen stretches, its cross section diminishes but so also does the tension, because of the increase of θ. Denote by l_o the initial half-length of the specimen, by l a stretched length, and by A_o its initial cross-sectional area.

For a weight W, the tension $T = \frac{Wl}{\sqrt{4l^2 - D^2}}$ and the stress is $\frac{T}{A} = \frac{Tl}{A_o l_o} = \frac{Wl^2}{A_o l_o \sqrt{4l^2 - D^2}}$.

A condition is set up in which the stress when the specimen has been stretched 25 percent shall equal the initial stress—that is,

$$\frac{Wl_o}{A_o\sqrt{4l_o^2 - D^2}} = \frac{Wl_o(1.25)^2}{A_o\sqrt{4(1.25)l_o^2 - D^2}},$$

from which $l_o = 0.64D$. While this makes an exact solution for the points chosen, intermediate points are not exactly compensated for. Figure 7 shows the deviations from perfect correction for a number of different values of l_o in terms of D. It is seen that for $l_o = 0.65D$, the deviations are small compared to those existing when a load is hung from a vertical specimen. If it is known that the specimen will not be extended over 10 percent, then a somewhat different value ($l_o = 0.676D$) will give a closer fit over the 0–10 percent extension range.

Even when the purpose of load-extension or

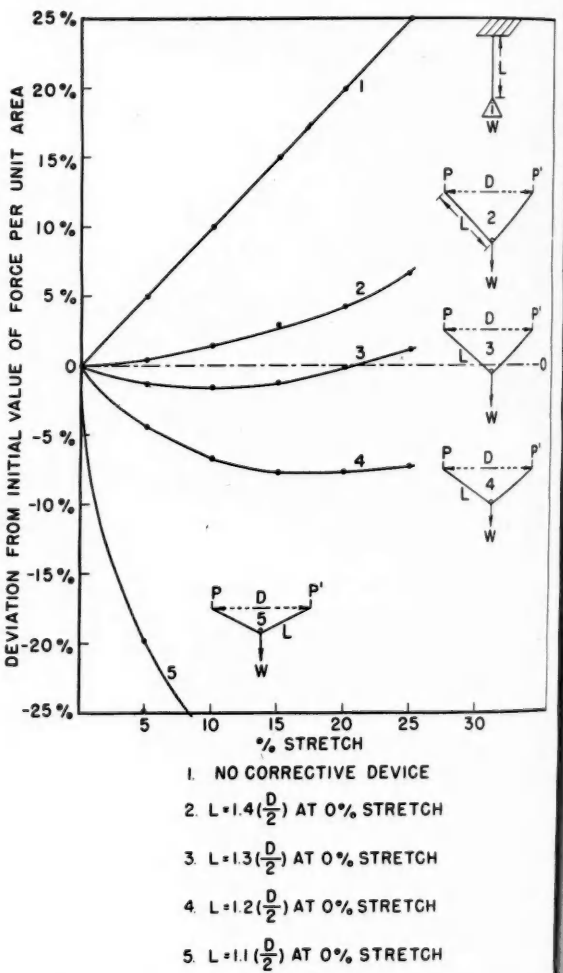

FIG. 7. *Simple arrangement for obtaining extension versus time at constant stress.*

extension-time curves is only to compare one specimen with another, it is better to take data under conditions which make stress, rather than total load, one of the basic variables. Such results will have a meaning for fundamental and theoretical studies and will also yield a better comparison of the materials themselves.*

* It is a pleasure to acknowledege the aid of Mr. L. L. Stahlberger in the construction of the apparatus shown in Figure 5.

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The Seal of the Textile Research Institute, Inc.

THE cover of this issue of the TEXTILE RESEARCH JOURNAL introduces to members and to the world of textiles the seal of the Institute, which has been officially adopted by the Board of Directors.

Within a circle representing the textile world, an equilateral triangle symbolizes the three basic steps in the conversion of textile fibers into fabrics: the production of yarn, the production of fabric, and the transformation of the fabric into its finished state by dyeing and finishing. To emphasize the great heritage of fine craftsmanship on which our modern textile industry rests, the three steps are represented by a spinning wheel, a hand loom, and a dye tub such as was used for dyeing piece goods by hand.

Within the triangle, a microscope on a field suggesting woven fabric stands for science, whose impact on the textile crafts has created the textile industry of today.

The seal thus represents not only the heritage and history of our industry but also the purpose of this Institute—namely, to serve the textile industry through the furtherance and conduct of research and of training by which scientific technology, hand-in-hand with skilled craftsmanship, can enhance the beauty, the utility, and therefore the value of textiles.

Electronic Control for Tensile Testing at Constant Rate of Load

R. J. Demartini

General Electric Company

ALTHOUGH the pendulum-type tensile tester in its present form violates one of the most fundamental rules of sound testing practice, it is recognized as the official instrument for determination of the tensile strength of textiles. No attempt is made to control the rate at which the load is applied. Since loading rate has a very significant effect on the tensile strengths reported, it is important that this variable, as well as all other variables except the one which is being measured, be closely controlled. Unless such measures are taken, it is impossible for laboratories to realize full benefit from the standardization of jaw design and gage length, and from costly equipment provided for the elimination of such other variables as temperature and humidity.

Data compiled by Haven * in tests performed on a total of 25 samples of 8-ounce duck illustrate clearly the effect of loading rate on reported tensile strength. In these tests, groups of five specimens were loaded to rupture at each of five pulling-jaw speeds, and the average of each group was computed (see Table I).

Comparison of these averages leads to the conclusion that tensile strength as reported by the pendulum machine is definitely a function of jaw speed or loading rate. Analysis of individual readings, however, reveals inconsistencies that require further explanation.

TABLE I

Specimen No.	Jaw speed—In. per minute				
	2.3	6	12	18	24
1	39.5	42.5	40.0	45.0	46.0
2	44.5	46.0	43.5	44.5	46.0
3	40.5	40.5	45.5	47.0	47.0
4	39.5	44.0	47.5	43.0	45.0
5	44.5	45.0	44.5	45.0	46.5
Average	41.9	43.6	44.2	44.9	46.1

Shortcomings of Standard Tester

Consider what happens to a specimen as it proceeds through succeeding steps in the testing cycle.

First, the operator inserts it between the jaws, taking care to align the crosswise yarns (in fabric testing) with the edge of the jaw. He attempts simultaneously to draw the specimen as tight as possible in order to insure that gage length specifications are adhered to closely and to guard against shock loading when the pendulum is accelerated into motion. Failure to exercise care in these detail rituals results in lowered tensile reading.

Next, after the loading has begun, the stress-strain characteristic of the specimen itself appears on the scene to influence results—that is, if the sample stretches greatly under tension, movement of the lower jaw will be largely absorbed in that stretching and the pendulum will move very slowly. On the other hand, should the specimen be rigid and ex-

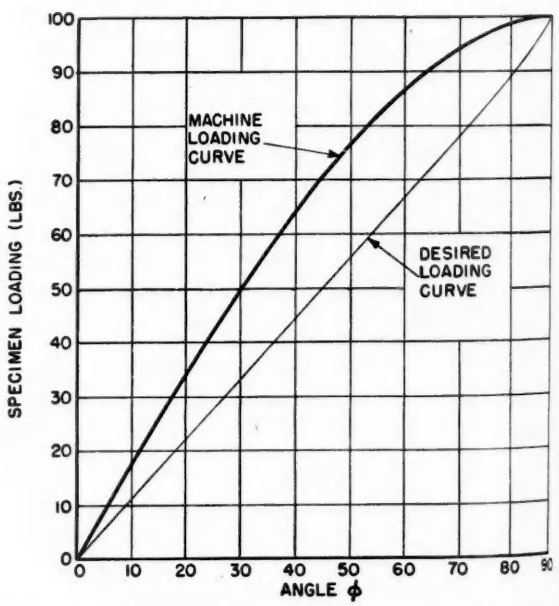

FIG. 1. *Plot of machine rate of load, illustrating deviation from constant rate of pendulum angular movement.*

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* *The Constant Load Rate Testing Machine for Textiles* in *The Proceedings of the American Society for Testing Materials.* Vol. 23, Part II, pp. 640, 1923.

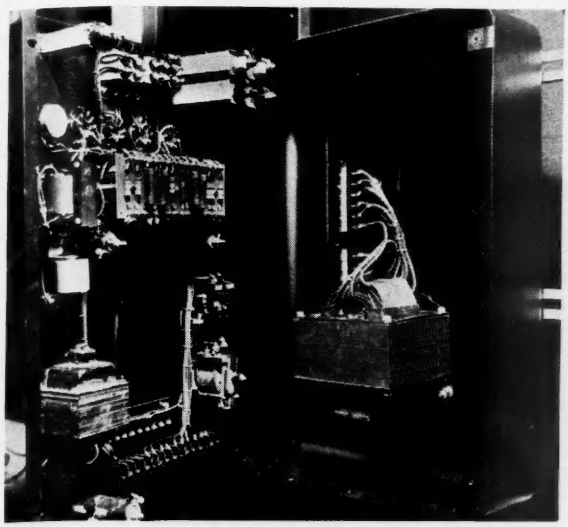


FIG. 2. *Electronic constant-rate-of-load control panel (interior view) for pendulum-type tensile tester.*

tend only negligibly under tensile load, the motion of the pulling jaw will be almost wholly transmitted to the weight arm. The arm, in turn, will swing through its arc at a rapid rate and will thereby apply the load at a relatively high rate. Therefore, despite

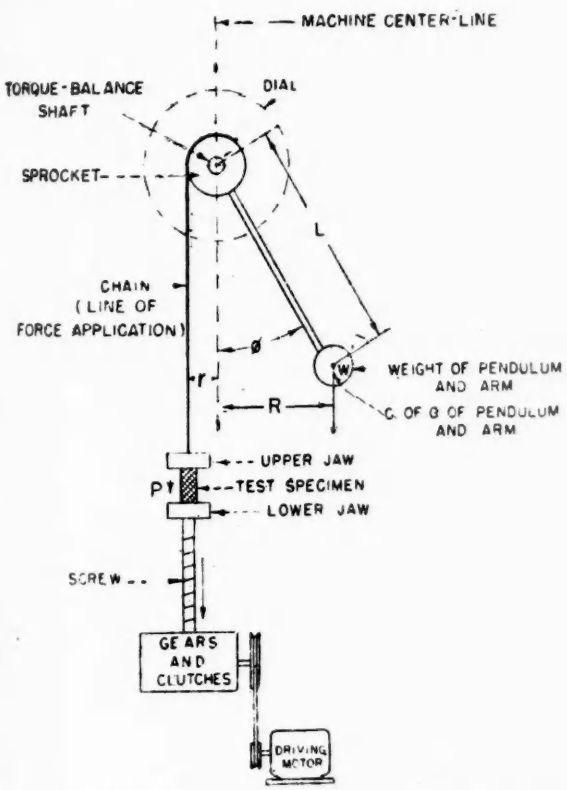


FIG. 3. *Diagram illustrating elements of standard pendulum-type testing machine.*

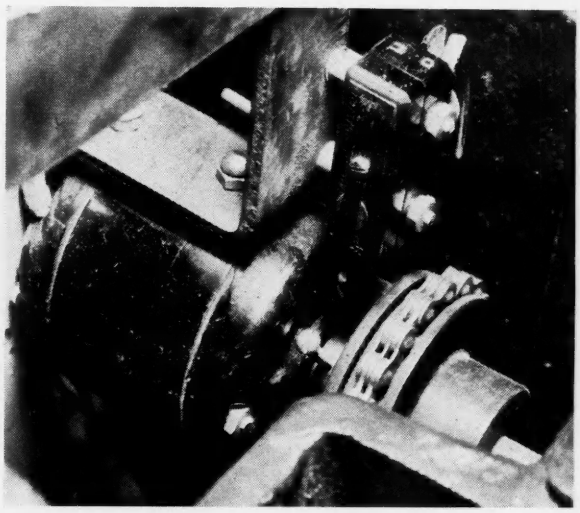


FIG. 4. *Selsyn connected to torque balance-shaft, behind load indicating dial, of pendulum-type tensile tester. Also shown is limit switch employed to transfer from idling to regulated motor speed.*

the fact that a constant motor speed is maintained, the rate of load—and consequently the reported tensile strength—is in part a function of the specimen's own load-elongation characteristic. This source of distortion is of particular significance when specimens of different constructions are tested for comparison.

Finally, as long as the constant speed drive is retained, a characteristic inherent in the design of pendulum loading mechanisms renders impossible the achievement of the ideal of a constant rate of load. The curve in Figure 1 illustrates the manner in which the load varies with the angular position of the pendulum arm. From this it is evident that rate of load would vary as a sine function even if the

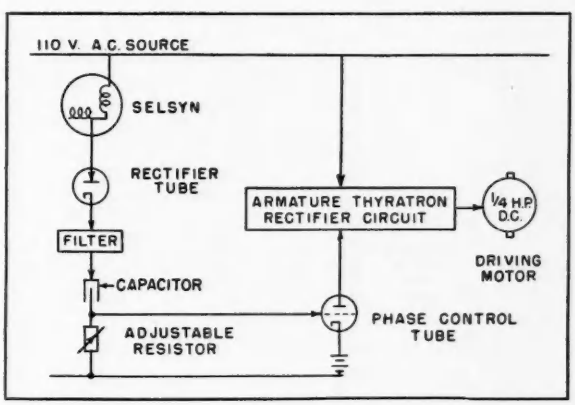
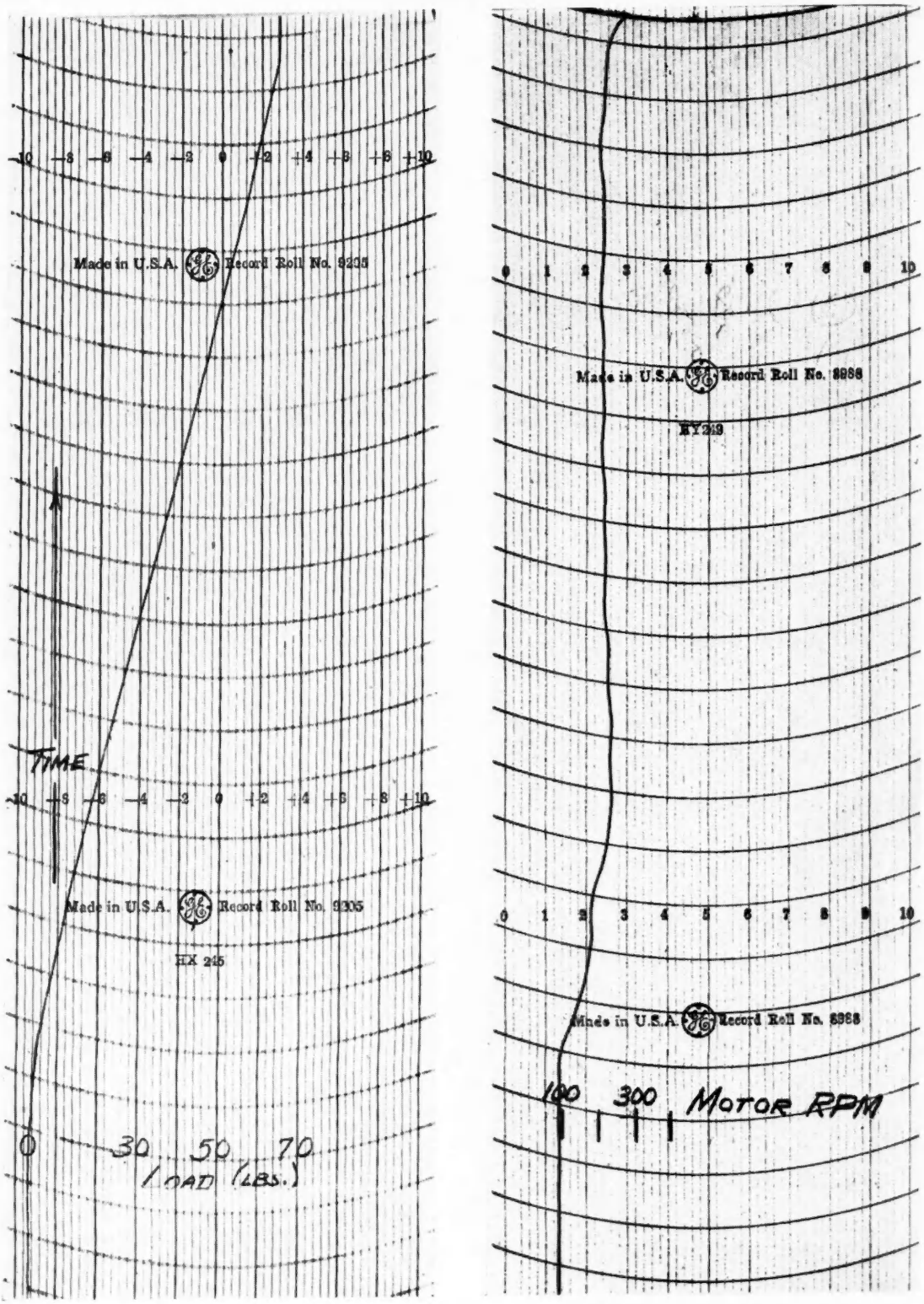


FIG. 5. *One-line diagram of electronic control circuit employed.*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TIME
Made in U.S.A. Record Roll No. 9205
HX 245
0 30 50 70
LOAD (LBS.)
Made in U.S.A. Record Roll No. 8988
HY 213
Made in U.S.A. Record Roll No. 8988
100 300 MOTOR RPM

FIG. 6. *Actual data curves taken during loading cycle on a sample of light nylon braid. Curve at left illustrates rate of loading and that at right the motor speeds required to hold this rate constant.*

pendulum could be made to swing through its arc at a constant angular rate for all specimens. Thus, regardless of the care exercised in inserting the specimen in the jaws and regardless of its load-elongation characteristic, this machine will load it at a continually varying rate.

Obviously, there exists a real need for a tensile testing machine in which these and similar distorting factors are prevented from influencing results.

Electronic Motor Control

With this objective in view an electronic motor control (see Figure 2) was developed jointly by Scott Testers, Inc., and the General Electric Company, to be applied to the standard pendulum-type machine. With the aid of this control

1. Variations due to inaccuracies of the operator are minimized.
2. The possibility of shock loading at the beginning of the loading cycle is eliminated.
3. Sample-to-sample variations in stretch characteristic are wholly compensated for.
4. The machine characteristic is wholly compensated for.

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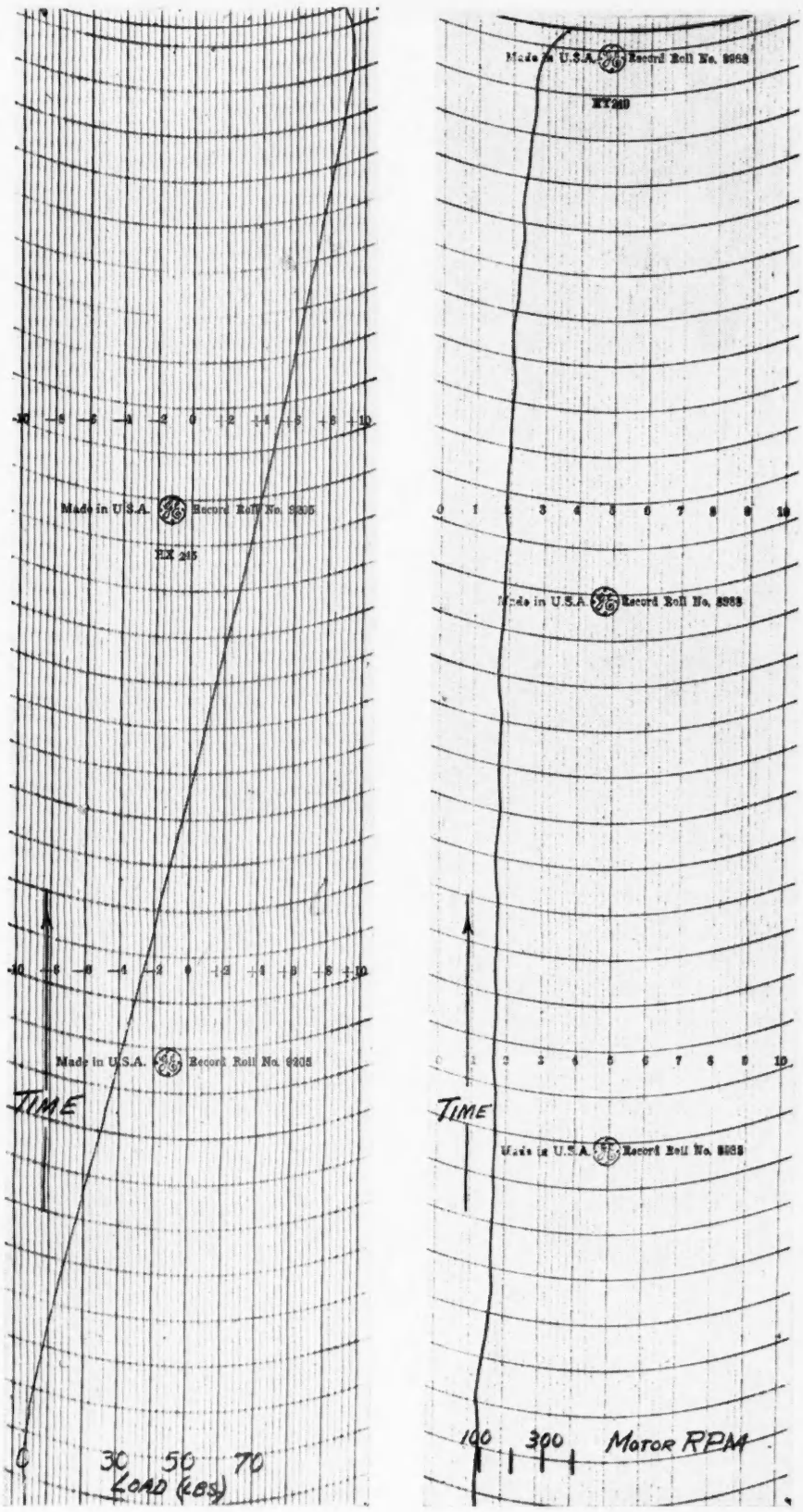
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EX 215
Made in U.S.A. Record Roll No. 9308
TIME
0 30 50 70
LOAD (LBS)
Made in U.S.A. Record Roll No. 8968
EX 210
Made in U.S.A. Record Roll No. 8968
TIME
Made in U.S.A. Record Roll No. 8968
100 300 MOTOR RPM

FIG. 7. *Actual data curves taken during loading cycle on a rigid steel specimen. Curve at left illustrates rate of loading and that at right the motor speeds required to hold this rate constant.*

The machine, so equipped, becomes capable of applying the load at a constant rate.

Theory of Operation

In Figure 3 are shown the basic elements of the pendulum-type tensile tester. A specimen clamped between the jaws is subjected to tensile stress as the driving motor, through intermediate gearing, draws the lower end downward. The magnitude of that stress is determined by the position of the weighted pendulum arm, which swings through an arc to oppose the downward pull. That is, the torque with which the pendulum resists rotation of the torque balance-shaft must equal that applied about the same shaft by the tension in the specimen.

$$P \times r = W \times R$$

but since

$$R = L \sin \phi$$

it is obvious that

$$P \times r = W \times L \sin \phi$$

The quantities r, W, and L are of fixed magnitude and therefore it may be concluded that

$$P \text{ varies as } \sin \phi \qquad (1)$$

To control the rate of increase of P, the load on the specimen, it becomes necessary simply to control the rate at which $\sin \phi$ changes. *If $\sin \phi$ can be made to increase at a constant rate, the loading rate too will be constant.*

To accomplish this (see Figure 4) a selsyn is directly connected to the torque balance-shaft so that its rotor turns with the pendulum arm. It is an inherent characteristic of this device that as its rotating member is turned through an angle, a continuous voltage signal proportional to the sine of the angle traversed appears at the rotor winding terminals.

This signal, received at the panel, is rectified, filtered, and then passed successively through a capacitor and a resistor (see Figure 5). The fundamental relation employed to calculate the current passed by a capacitor is as follows:

$$i = C\frac{dV}{dt} \qquad (2)$$

That is, the magnitude of this current (i) varies as the product of the value of capacitance (C) and the rate of change of selsyn signal voltage (dV/dt) impressed on the capacitor. C is fixed, and the value of dV/dt is determined by the rate at which the pendulum arm swings through its arc—i.e., the rate of increase of $\sin \phi$. Passing through the resistor, the current causes a voltage drop to be established across it, a voltage drop of magnitude directly calculable from Ohm's Law ($E = iR$). This voltage (E) in turn is impressed on the grid of the phase-control tube of a standard electronic motor-control circuit. Speed of the D.C. driving motor is thereby controlled.

Consider how these mathematical relations interact to provide a constant rate of load. By setting a calibrated dial the operator selects the desired loading rate. The anode-to-cathode voltage on the phase-control tube is thereby established. Suppose, then, that the specimen under test is of such construction that it tends to stretch considerably under load. Since movement of the lower jaw will tend to be largely absorbed in the stretching, the pendulum will have a tendency to move at a rate slower than that required for maintaining $\sin \phi$ constant. But when

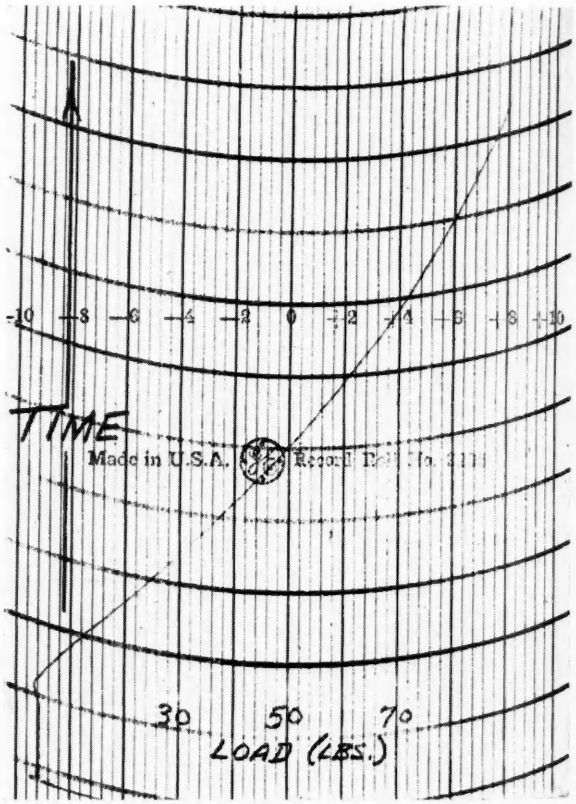

FIG. 8. *Curve of rate of load drawn by recording instrument during fillingwise tensile test on zipper tape. Test performed 12 in./min. lower-jaw speed (A.S.T.M. method). Note shock loading at start of test and varying rate of load throughout the balance of the cycle.*

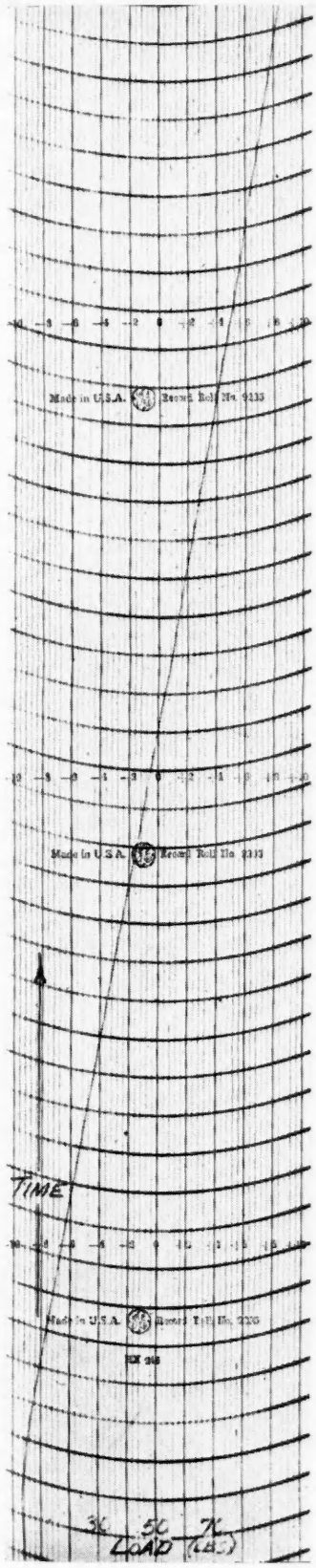

FIG. 9. *Curve of rate of load drawn by recording instrument during fillingwise tensile test on zipper tape. Electronic control here maintained rate constant. Compare with Figure 8.*

this lag develops, it will be accompanied by a reduction in the rate of increase of selsyn voltage (dV/dt). From equation (2) it is obvious that the current i will thereby be reduced. In turn, by virtue of the operation of Ohm's Law, the grid voltage is reduced. Lowered grid voltage means reduced conductance through this phase-control tube, and hence the speed of the driving motor is increased. This increase in speed is precisely what is required to compensate for stretch in the specimen and to quicken the rate of pendulum travel.

The time actually required for consummation of this sequence is of the order of a few cycles. In the course of a test the control is called upon to correct many times, but its operation is so fast that there is no trace of jerkiness in the pendulum motion.

In order to determine how well the control performs the functions for which it was designed, a series of tests was conducted and the data were plotted by recording meters. By placing the rectified selsyn voltage across the terminals of one instrument it was possible to make a permanent record of the rate of pendulum travel (the rate of load). Then, to the motor shaft was connected a tachometer generator which produced a signal proportional to the motor speed. This signal was fed to a second recorder which drew a plot of the speed changes required over the loading cycle to maintain the loading-rate constant. Chart speeds on the two instruments were the same—36 inches per minute.

In Figure 6 are curves drawn on the two recorders during a test on a sample of light nylon braid. Figure 7 shows similar curves obtained in a test run on a bar of steel. A gage length of 1 inch was selected and the loading rate was arbitrarily set at 3.9 pounds per second. Analysis of these curves serves to illustrate the method of operation of the control and to emphasize certain significant facts:

1. The motor is required to operate at higher speeds when testing high-stretch materials than are attained in tests on rigid specimens.

2. The curve of speed versus time for steel illustrates particularly well the manner in which motor r.p.m. must increase to compensate for the inherent machine rate of loading.

3. Despite marked differences in stretch characteristics of the two samples, rate of load is held constant for both and is duplicated exactly.

Elimination of the shock-loading "bump" which is encountered as the pendulum is accelerated from

rest is accomplished by a scheme for holding motor speed constant at a very low level so long as any slack exists in the specimen and for introducing the rate of load control only after there is positive assurance that all of the slack is removed. With the motor turning over slowly and the driving gears engaged, the pendulum stands in the vertical position as the specimen is gently pulled taut. Finally, the pendulum crawls away from the vertical. When it has traveled through approximately 2 degrees of its arc, it trips a limit switch (see Figure 4) and thereby brings into operation the electronic constant rate of load control. There is no "bump." The specimen is protected against serious damage which might influence greatly the reading of the tensile strength ultimately obtained.

In Figure 8 is shown the time-versus-load curve drawn during a fillingwise tensile test on heavy zipper tape. The drive was a constant-speed motor, specified as standard by the American Society for Testing Materials. The lower-jaw speed was 12 inches per minute, and the gage length was ¼ inch. The fact that a shock load was imparted to the specimen at the beginning of the loading cycle is unmistakable. The curve also illustrates nicely the manner in which the machine, powered by the constant-speed drive, applied load at a constantly changing rate.

For purposes of comparison, there is shown in Figure 9 the curve drawn during a test on a duplicate sample on a machine equipped with the electronic control. Despite the short gage length, the initial application of load was gradual and without indication of instantaneous high stress. A uniform loading rate was then maintained to the point of rupture.

Flexibility Features Incorporated

In anticipation of the need for a wide range of loading rates to fulfill requirements of laboratories working with many differing types of materials, provision has been made for stepless adjustment over a wide range. By selection of appropriate motor and gear combinations, the range available by electrical adjustment may be greatly broadened.

Similarly, as further insurance against initial shock-loading, a dial adjustment is provided to permit selection of whatever idling speed is deemed most conducive to a smooth transition.

Finally, because testing at constant pulling-jaw speed is still recognized as official by A.S.T.M., a switch is provided for switching over to this type of operation. Therefore, though it may be desired to test at constant-rate-of-load for research and development while continuing to adhere to A.S.T.M. practice in quality-control work, for the present, at least, a single machine equipped with this versatile electronic drive satisfies all requirements.

Conclusion

Performance of the new control in developmental test and in service in a textile laboratory indicates that it is capable of eliminating the objectionable characteristics heretofore accepted in pendulum-type machines. It is now presented for consideration by the industry.

Scientific Bankruptcy?

IT has been reported—"It is significant that both Great Britain and Russia, in an effort to avoid the possibility of 'scientific bankruptcy,' have maintained substantially their normal number of students in technical training, while in this country the rate is only a small fraction of that of prewar years."

Determination of Nitrogen in Textiles

Solomon Frankfurt

Pacific Mills Research Laboratory, Cotton and Rayon Division, East Newark, New Jersey

THE modification of the Kjeldahl method for the determination of nitrogen described herein is adapted to the requirements of the research work of Pacific Mills Research Laboratory for testing the treatment of fabrics with different nitrogen compounds. This method has the advantage of being simple to handle and easy to adjust for different samples containing varying amounts of nitrogen. It yields satisfactory results when the content of nitrogen is low or when its distribution is not uniform. The determination can be made in a short time, and parallel analysis can be repeated without making a new digestion.

A complete survey of the methods described in the literature has been made by R. B. Bradstreet [1].

The outcome of the analysis depends in great part on the choice of the catalyst.

A study of the use of perchloric acid as a catalyst was made by L. P. Pepkowitz and his collaborators [2]. From their paper it can be seen that in using this compound caution must be exercised because of its explosive nature and the possibility of the oxidation of ammonia to nitrogen. The time needed for the digestion is given as 20–25 minutes, with a 10-minute interval for cooling. The use of a copper selenite catalyst is simpler and the time of digestion is shorter.

In the chemical laboratory of Pacific Mills, the Kjeldahl method is used for the determination of nitrogen in cotton fabrics, often on a multiplicity of samples. Experience has shown that the fabric material is not homogeneous, and that the content of nitrogen is usually low. This explains why larger samples and standard solutions of low normality must be used to increase the precision of the determination. In reading the volume of the burettes, a difference of only 0.1 milliliter of a 0.1N solution corresponds to 1.0 milliliter of an 0.01N solution.

Apparatus

The apparatus (Figure 1) consists of a Kjeldahl flask (a) of about 250-milliliter capacity. This flask is attached to a glass funnel (b) with a ground-glass stopcock. The tube of the funnel (c) leads to the bottom of the flask. This tube extends through a spherical bulb (d) that is connected with the flask through a carefully ground joint (e). From this bulb a widened tube (f) leads to the Alling condenser (g) (which affords sufficient length and prevents sucking back of the liquid from the receiver to the digestion flask) by means of a bent tube to which a rubber stopper is attached. The bulb and attached connection tube serve as a trap for the alkali that can be carried from the flask while the distillation with the sodium hydroxide is taking place. At the end of the condenser is a glass tube which leads the distillate to the bottom of the receiver (h), which consists of a 250-milliliter Erlenmeyer flask.

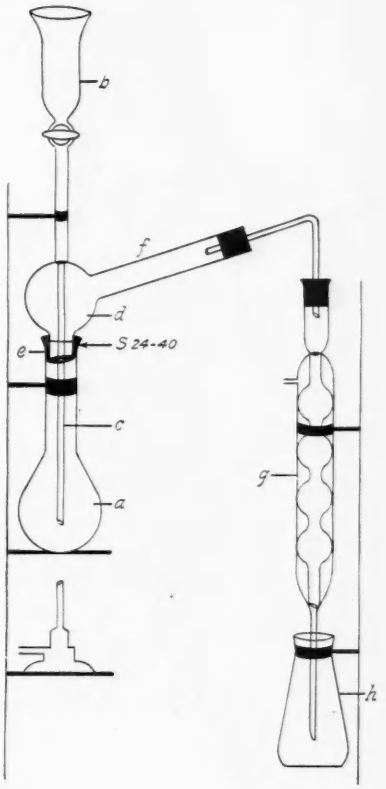

FIG. 1. *Apparatus for determining the amount of nitrogen in textile materials by a modification of the Kjeldahl method.*

Pipettes of 50-milliliter capacity are used for measuring the aliquot portions into the flasks for distillation.

Procedure

An average sample of about 2.7–2.8 grams is put into a weighing bottle which has a ground-glass cover. It is then dried in an oven at 105°C, placed in a desiccator to cool, and weighed. The dry weight of the sample should be about 2.5–2.6 grams. The sample is then put into a Kjeldahl flask, and 5 grams of the copper selenite catalyst are added. The latter is prepared by mixing carefully 90 grams of potassium sulfate powder with 10 grams of copper selenite. A grain of paraffin is also added to prevent foaming in order to smooth the digestion process. To the contents of the flask are added about 25 milliliters of concentrated sulfuric acid, and the flask is shaken gently until the acid penetrates the whole sample. The flask is then placed on the metal stand in a hood over the full flame of a gas burner. After 5–7 minutes, the contents of the flask begin to boil vigorously, and after 12–15 minutes they turn a clear green color tinged with blue. A short time after the heating has ceased, the flask is cooled sufficiently so that it may be put into a beaker of cold water. The contents of the flask are then diluted to the correct volume for the amount of nitrogen present in the original sample. If the amount is 0.2 percent or more, the solution is diluted to 1,000 milliliters; when it is less than 0.2 percent, the solution is diluted to 500 milliliters.

Fifty milliliters of the solution are then pipetted back into the original Kjeldahl flask. To be sure that the required amount of sodium hydroxide is added, a few drops of phenolphthalein indicator are put into the flask. To insure quiet boiling, a small piece of zinc, which releases hydrogen from boiling alkali, is introduced.

The flask is then attached to the distillation apparatus described above. Care must be taken to insure the tight joining of the ground-glass parts. Vaseline is used as a lubricant to attain tight joining, and also to prevent the joints from "freezing." The sodium hydroxide (5 percent solution) is then run through the funnel into the flask, until the contents of the flask become a clear pink color. A great excess of alkali should be avoided, since in reacting the zinc can cause strong eruption of foam. The amount of sodium hydroxide to be added depends upon the acidity of the solution. The amount needed for neutralization of the acid used in digestion is about 10 grams for 50 milliliters of the solution pipetted from the 500-milliliter dilution, and 5 grams for the solution diluted to one liter (or about 50 milliliters of 20 percent or 10 percent, respectively, for each solution). As a considerable part of the sulfuric acid is lost following the decomposition and evaporation, there is an excess of alkali, which should be controlled as much as possible. The phenolphthalein indicator helps to regulate the volume of the alkali to be added; about 75 milliliters will be sufficient.

The total volume of the solution in the flask will be about 125 milliliters. Before the flask is joined to the condenser, 25 milliliters of the 0.01N sulfuric acid are put into the Erlenmeyer flask beneath the condenser. The tip of the condenser is placed under the level of the liquid. The distillation can then proceed with full force until half of the liquid in the flask has distilled over into the receiver, which will contain 60–70 milliliters of solution when the distillation is completed.

This process takes about 10–15 minutes. Next, the receiver is lowered so that the end of the tube is above the surface of the liquid. The boiling is continued for a few minutes in order to wash down the condenser with the condensed steam.

Methyl red is used as an indicator with the acid in the receiver, and the liquid must remain red until the end of the distillation. Before retitration with diluted alkali, the solution in the receiver is heated to boiling in order to eliminate any carbon dioxide which may be in the solution.

The described way of using diluted standard solutions 0.01N and the dilution of the liquid resulting from the process of digestion has the following advantages:

1. It is possible to adjust the aliquot portion taken for distillation to the amount of nitrogen present in the sample.
2. In case a repetition of the distillation process is advisable, it may be made without repeating the digestion process.
3. The distillation of the diluted solutions proceeds smoothly.
4. The amount of sodium hydroxide needed is reduced to 10 or 5 percent.
5. The time needed for completing one determination is about 30 minutes, and two parallel determinations may be made at the same time without

TABLE I

Sample No.	Sample Weight	Dilution After Digestion	Mls. Taken for Distillation	Percent Nitrogen
A 142	1.8503 grams	Whole solution	Whole solution	0.090
A 142	1.8475 grams	Whole solution	Whole solution	0.092
A 128	2.1175 grams	Whole solution	Whole solution	0.076
A 128	2.1191 grams	Whole solution	Whole solution	0.078
35 W	1.9758 grams	Diluted to 1 liter	50 mls.	0.240
35 W	1.9648 grams	Diluted to 1 liter	50 mls.	0.240
47–2	1.8946 grams	Diluted to 1 liter	50 mls.	0.147
47–2	2.5265 grams	Diluted to 1 liter	50 mls.	0.144
1021–50	1.0293 grams	Diluted to 1 liter	50 mls.	4.10
1021–50	1.0188 grams	Diluted to 1 liter	50 mls.	4.10

any difficulty; or four determinations may be made in an hour. Therefore it is possible to make 25–30 determinations per day.

6. That the results are precise and that the parallel analyses yield uniform results may be seen from Table I.

The procedure described here was employed in the analysis of cotton samples. It may be easily adjusted to other materials, with the use of the same apparatus, the same dilution of digested solution, and the same standard solutions. Aliquot portions of the liquid resulting from digestion and dilution may also be used, as is explained above.

Literature Cited

1. Bradstreet, R. B., *Chemical Review* **27**, 331 (1940).
2. Pepkowitz, L. P., *et al.*, *Industrial and Engineering Chemistry, Analytical Edition* **14**, 856–914 (1942).

Tower of Babel

"AT the present time workers in the various branches and divisions of science do not understand each other any too readily, and the layman finds the language of all of them quite incomprehensible.

". . . At one time, all varieties of scientists and intelligent laymen as well could meet together in their academies and, to judge from accounts, have quite an exciting time discussing the newest discoveries in botany or astronomy. Now even different species of chemists such as organic and physical chemists are as far apart in their speech as a Greek and a Roman.

"A modern scientific meeting often reminds us of the conversation between Cassius and Casca:

'Cassius: Did Cicero say anything?

'Casca: Ay, he spoke Greek.

'Cassius: To what effect?

'Casca: Nay, an' I tell you that I'll ne'er look you i' the face again; but those that understood him smiled at one another and shook their heads; but, for mine own part, it was Greek to me.' "—From an address by Dr. Robert C. Hockett.

ABSTRACTS

SERVICES AVAILABLE

Reprints of the original articles abstracted in TEXTILE RESEARCH JOURNAL *are often available from the publishers. Otherwise, it may be possible to secure copies of the periodicals. A list of periodicals, the abbreviations used in references to articles, and the addresses of publishers of English language publications was given on page 22 of the January, 1945, issue. Orders should be sent direct to the publishers.*

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ANALYSIS: TESTING LABORATORY METHODS

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Calibration of pH Meters

Comparative liquid-junction potentials of some pH buffer standards and the calibration of pH meters. George C. Manov, Nicholas J. DeLollis, and S. F. Acree. *J. Research Natl. Bur. Standards* **34**, 115–27 (Feb. 1945).

By application of the equation pH = $(E - E_{ref} - E_j)/k$ to solutions whose pH values were known accurately, the sum of the potentials of the reference electrode and of the liquid-junction potential, $E_{ref} + E_j$, was obtained at 25°C by the method of cells with liquid junction for 7 solutions suitable for standards of pH. The solutions used were 0.01018-*m* hydrochloric acid, pH 1.081; 0.01-*m* hydrochloric acid +0.09-*m* sodium chloride, pH 2.101; 0.05-*m* potassium acid phthalate +0.02-*m* potassium chloride, pH 3.989; 0.02-*m* potassium dihydrogen phosphate +0.02-*m* disodium hydrogen phosphate +0.02-*m* sodium chloride, pH 6.863; 0.02-*m* potassium phenolsulfonate +0.002-*m* potassium sodium phenolate-sulfonate +0.02-*m* sodium chloride, pH 8.795; 0.02-*m* boric acid +0.02-*m* sodium borate (added together as sodium tetraborate) +0.02-*m* sodium chloride, pH 9.155; and 0.01727-*m* calcium hydroxide +0.01819-*m* sodium chloride, pH 12.38. Silver-silver- chloride electrodes immersed in saturated potassium chloride solution were used rather than the calomel electrodes customarily employed. As E_{ref} remains constant when the buffer is changed, values for the differences in the liquid-junction potentials of various buffers in contact with saturated potassium chloride solution were obtained from the data. These differences were then used to calibrate 7 Type 015 and 3 "low-alkali error" glass electrodes of commercial manufacture. The average agreement between the true pH of the buffer-chloride solution (determined from cells without liquid junctions) and that read on various commercial pH meters when corrected for the differences in the liquid-junction potentials and the alkali error of the electrode was 0.01 pH unit. The data also furnish a critical test of the consistency of the pH values assigned to the various buffer solutions recommended by this Bureau for the calibration of the pH scale and for checking pH meters. Recommendations are made for checking pH meters.

Authors

Alpha Cellulose Determination

α-cellulose determination on pulps of different viscosities and degrees of purification. R. Axling. *Svensk Papperstidn.* **47**, 602–4 (1944) (through *Chem. Abstr.* **39**, 2402⁹, June 10, 1945).

The α-cellulose content (*I*) of pulp is determined in Sweden either indirectly or gravimetrically as resistant *I*. The results obtained by the 2 methods are not identical, the discrepancy becoming the greater, the lower the viscosity of the pulp. Neither the method of degradation nor that of purification is responsible for the difference. The values determined indirectly are in direct relation to the actual yields obtained in the manufacture of rayon and staple fiber. However, purchasers of dissolving pulp specify the *I* determined according to some gravimetric method. The values thus obtained do not correspond to the rayon yield which this pulp will give. The lower the viscosity of the pulp, the greater will be the discrepancy. This fact is of considerable importance from the sales angle, because pulps of low viscosity will appear to have low *I*, whereas they actually represent qualities which are far more expensive to manufacture.

Cellulosic Dispersions

A tumbling device for preparing cellulosic dispersions. S. A. Simon. TEXTILE RESEARCH JOURNAL **15**, 82–3 (Mar. 1945).

A new tumbling device is described in which the usual end-over-end action is supplemented by a very slow rotation of the viscometer about its own axis. Successive passes of the agitating plunger are distributed around the circumference of the viscometer rather than localized on

two opposite sides only. With this axial rotation the plunger is enabled to seek out the weak spots in the adhering cellulose on the walls of the pipette and thus to initiate the removal and dispersion at an early stage. Continuation of this action clears the entire side wall, which might otherwise never be touched by the plunger. J.

Structure of Cellulose

Röntgen- and electron-optical methods for the determination of the constitution of organic molecules and their application to the study of the structure of high-molecular fibrous materials—I: Cellulose. Schiebold. *Beih. Z. Ver. deut. Chem. A: Chemie, B: Chem. Tech.* **1943**, No. 47, 75–7; *Chem. Zentr.* **1943, II**, 1266 (through *Chem. Abstr.* **39**, 2195[8] (May 20, 1945)).

With native cellulose as an example, details of the investigation of the fine structure of high-molecular fibrous materials are discussed. The structure of cellulose is considered in detail.

Load-Elongation Instrument

Load-elongation recorded by new device. Harry C. Brown. *Textile World* **95**, 123, 125 (June 1945).

An instrument developed at Lowell Textile Institute is described which traces load-elongation curves of yarns or fibers at constant rate of elongation. The specimen is clamped vertically between two jaws. The upper jaw is moved upward at constant speed. The lower jaw is fastened to a balance arm which is kept in a horizontal position by the chainomatic principle, the chain being controlled by a small motor, which is in turn controlled electronically. Recording is accomplished by having the upper jaw motor revolve a drum chart and the chain motor control the pen movement. Although it is not so stated, the capacity of the instrument at present is apparently 0.2 lbs. It is said that changes are in progress to increase the capacity to 1 lb. and that it could be increased to 20 lbs. or more. H. J. Burnham

Microscopy in Cotton Research

Some applications of microscopy to cotton research. T. L. W. Bailey, Jr., and Mary L. Rollins. TEXTILE RESEARCH JOURNAL **15**, 1–6 (Jan. 1945).

Techniques employed in the study of the effect on fibers, yarns, and cords of various chemical and finishing treatments are described and illustrated by photomicrographs of cross sections. The difference between an ordinary tire cord and one that has been "wet-stretched" is shown. The greater compactness of the fibers in the "wet-stretched" cord is clearly illustrated. J.

Pulps for Cellulose Acetate

Tests showing the suitability of pulps for the production of cellulose acetate. G. Jayme and U. Schenck. *Cellulose-chem.* **22**, 54–6 (1944) (through *Chem. Abstr.* **39**, 2402[4], June 10, 1945).

The methods, which are highly reproducible, depend on the following techniques: the rasped fiber is treated with glacial AcOH at 90° for 3 hrs., cooled, filtered, and washed with AcOH until the filtrate is colorless. This activated residue is then acetylated with a mixture of AcOH, H_2SO_4, and Ac_2O under carefully standardized conditions with thermostat control, which are described in minute detail. At the end of the acetylation period, the turbidity of the solution is measured by means of an auxiliary part of the Pulfrich photometer. The value obtained is termed the "initial turbidity value" (*I*). The turbid solution is then centrifuged at 3,000 r.p.m. for 5 min., and poured from the residue and this operation is repeated 3 times (or until the turbidity of the solution remains unchanged). After centrifuging, the turbidity is again determined and this is termed the "final turbidity value" (*II*). The undissolved residue (*III*) is filtered, washed successively with AcOH and H_2O, dried, and weighed. The difference between *I* and *II* and the magnitude of *III* indicates whether or not the pulp is suitable for acetate formation. However, the gross differences between different pulps are well shown by *II* alone. If a highly purified cotton linters (99.8% alpha) is taken as standard, and if the value *II* is arbitrarily set as 100, *II* of a highly purified spruce sulfite pulp was 880, and of an ordinary sulfite dissolving pulp was 1,520. Thus *II* serves to accentuate certain characteristic differences in the pulps, in which *III* was, respectively, 0.15, 0.38, and 10.24%. The pretreatment and the standardized acetylation require approximately 2 working days prior to the determinations of *I*, *II*, and *III*.

Tire Cord Testing

Tension vibrator compares tire cord values. L. Larrick. *Textile World* **95**, 107–9, 194, 196, 198, 200, 202 (May, 1945).

An instrument developed by Goodrich for testing the fatigue resistance of tire cord is described. Lengths of cord are suspended under a static load which is a fraction of the apparent tensile. The grip from which the cord is suspended is subjected to approximately simple harmonic vibration in the vertical plane of the cord, a portion of the cord between the grips being heated in order to accelerate the tests. The capacity of the instrument is 16 cords, and 8 lengths of one cord are tested against 8 lengths of another cord. Tables of test results are given, as well as pictures of the instrument. H. J. Burnham

Viscometers

The vertical mounting of viscometers. Anon. *Chemistry and Industry* **No. 5**, 39 (Feb. 3, 1945).

A device is described that permits viscometers to be mounted vertically with an error of less than 10′ of an arc. A. R. Martin

Yard Scanner

New yarn scanner measures diameter variations. Anon. *Textile World* **95**, 139 (June 1945).

A very brief description is given of

the yarn scanner developed by the U. S. Rubber Co. which records yarn diameters as measured by passing the yarn between a light source and a photoelectric tube. Short-length variation is continuously recorded and tests are nondestructive to the yarn. A picture of the outside of the instrument is shown. H. J. Burnham

CHEMICAL AND PHYSICAL RESEARCH

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Cellulose Chemistry

Recent progress in cellulose chemistry. W. Badgley, V. J. Frilette, and H. Mark. *Ind. Eng. Chem.* **37**, 227–32 (Mar. 1945).

Recent progress is reported in the field of cellulose and its derivatives in three respects: (1) the size and shape of cellulose molecules in dilute solution, (2) the polymolecularity of cellulose acetates; and (3) the existence of more or less easily accessible areas in bulk cellulose, particularly in fibers. The first and last items are apparently closely related to important mechanical properties of films and fibers made from cellulose or cellulose derivatives, such as ultimate tensile strength and elongation to break. They seem to be particularly important for the so-called transversal properties, such as resistance to folding, bending, and shearing, but they influence other important technical qualities such as moisture regain, swelling, dyeing, softness, and luster. The second point appears to be of interest for the behavior of spinning and casting solutions, particularly for the degree of orientation and crystallinity which can be expected if such solutions are subjected to certain coagulating and stretching operations. 42 references. Authors

Cellulose

The manner in which native cellulose reactions occur: I—Fiber structure as a retardant of cellulose reactions. Richard Bartunek. *Cellulosechem.* **22**, 56–63 (June, 1944). In German (through *Bull. Inst. Paper Chem.* **15**, 319 (May, 1945)).

Based on laboratory and industrial experiments, the hypothesis is advanced that, as the result of the stratified fibrillar and fine structure of cellulose, diffusion processes are retarded. In viscose formation, mercerization is retarded because the aqueous sodium hydroxide solution, as it penetrates the fiber, becomes reduced in strength. Xanthate formation is slowed down because of the difficulty of carbon disulfide diffusion, and the treated fiber dissolves only when the swelling pressure within the fiber layers is sufficiently great to rupture those outer layers which swell very little or not at all. In testing fibrous material, the author devised rapid practical control methods which are described in detail. The "lignin number" depends upon the treatment of the fiber with 13% nitric acid at 40° and by effecting a colorimetric comparison of the yellow color (resulting from dissolved lignin derivatives) with a standard solution of potassium bichromate and potassium permanganate. An arbitrary color scale is developed in this way and, assuming a color value of 1 for an ordinary bleached pulp, dissolving pulps have a lignin number range of 0.02–0.3. The degree of bleaching of a pulp may be measured in terms of a carefully standardized microscopic staining reaction with malachite green. Similarly, "carbolated gentian violet" (von Fram's stain), which is fixed by acid groups of the fiber, serves as a measure of the carboxyl groups and of the degree of injury caused by oxidation. Xanthate viscosity and degree of polymerization were determined by a standardized laboratory xanthation procedure which is described in detail. The so-called "resistance to mercerization" (*I*) of a pulp is determined by treating the pulp under standardized conditions with a solution of sodium hydroxide (85 g./l.) in an amount insufficient to complete the mercerization. The partially-formed alkali cellulose is then treated with a large excess of carbon disulfide, and the fibrous residue which remains insoluble in sodium hydroxide is separated by centrifuging and by washing with aqueous sodium hydroxide, dilute hydrochloric acid, dilute ammonium hydroxide, and water, and is dried and weighed. Thus *I* is given in terms of percentage of undissolved fiber. "Resistance to xanthation" (*II*) of a pulp is determined by treating with sufficient (200 g./l.) aqueous sodium hydroxide to insure complete mercerization, but with insufficient carbon disulfide to give complete xanthation. The unattacked fibrous residue is treated with 100 g./l. sodium hydroxide and is separated by the process described for *I*. The "resistance towards viscose formation" for a specific pulp is the average of *I* and *II*. The influence of the hemicellulose content of alkaline steeping liquors on the magnitude of *I* was also determined. Data are given for two commercial spruce and one beech sulfite pulp. In general, *I* (as determined by using pure sodium hydroxide) showed an increase when alkaline steeping liquors containing hemicelluloses were used. Correlations between degree of polymerization and *II* for the pulps are shown graphically and discussed.

Cellulose Esters

Interchain order and orientation in cellulose esters. W. O. Baker. *Ind. Eng. Chem.* **37**, 246–54 (Mar. 1945).

Study of the molecular, fine structure of cellulose derivatives as affected by their composition and fabrication is the purpose of this report. Other papers in this symposium show effects of composition and fabrication on physical properties and utility. Thus, in conjunction with these data, and by work yet to be reported, the fundamental connection between the habits of the chain molecules and the mechanical and electrical properties of finished plastics is further established. Molecular arrangement, as indicated by x-ray diffraction, has been investigated in various cellulose esters and mixed esters. The first part of the paper reflects operations such as extrusion, mold-

ing, cooling, and cold working during processing of any cellulose plastic; the latter part treats chain substitution and plasticizer as variables in the fine structure. A brief comparison of starch and cellulose esters emphasizes differences between polymer structures with the same empirical formula. 47 references. Author

New Starch Coatings

Newer starches for paper coating. C. C. Kesler and E. T. Hjemstad. *Paper Trade J.* **120**, 56–8 (Apr. 19, 1945).

A new starch-urea resin reaction product has been developed which possesses several desirable characteristics which are not found in the ordinary varieties of starch. Varying degrees of water-resistance may be developed upon proper treatment, adhesiveness is increased, tendency to retrograde has been inhibited, and the amount of free water apparently decreased. This product has been used successfully as a binder in clay paper coatings. Increased water-resistance may be obtained if desired. Studies are now in progress which it is believed will lead to the development of improved paper coatings. Through studies of shrinkage of starch films, it is hoped that improved characteristics may be imparted to starch as an adhesive. Author

Diazo-Coupling Reaction

The mechanism of the diazo-coupling reaction: Part 4—The decomposition of diazotized aniline at different pH values. H. H. Hodgson and E. Marsden. *J. Soc. Dyers and Colourists* **61**, 20–1 (Jan. 1945).

The decomposition of diazotized aniline at six pH values from 10.5 to 4.2 has been studied and the results support the theory, previously elucidated, of a coupling mechanism between diazohydroxide and phenol. The pH values used were obtained by the presence of appropriate metallic hydroxides, into suspensions of which diazotized aniline was mixed and decomposition allowed to proceed. Analysis of the end-products showed a decrease in the amount of mono-coupled products with corresponding increases in di-coupled and tri-coupled products with rise in pH (the latter up to pH 8.8 only), illustrating the fact that the rates of decomposition relative to the rates of coupling decrease as the pH value increases. K. S. Campbell

Organic Ion-Exchange Materials

Some properties of organic ion-exchange materials. E. L. Holmes. *J. Soc. Dyers and Colourists* **61**, 39–40 (Feb. 1945).

The nature, properties, and uses of organic ion-exchange materials are briefly described. The basicity of the anion-exchangers is dependent upon the presence of basic nitrogen groupings, while cation-exchangers owe their properties to the sulfonic groups present. Anion-exchange is probably more correctly represented as chemical adsorption since in the process the trivalent nitrogen atoms become pentavalent. The newer type of anion-exchange materials is based upon the manufacture of synthetic resins with considerably increased basic strength. The usefulness of these substances results from their almost complete water-insolubility and their capacity for regeneration when exhausted—i.e., by treatment with acids and alkalies. Concentration of the electrolyte in the solution to be treated is a factor in the efficiency of the cation-exchange type and somewhat limits the economic value of both. Thus to make sea water potable the volume of exchangers necessary is greater than that of the pure water produced. Such purification operations as removal of ammonia from water supplies, mineral residue from gelatin, formic acid from formaldehyde, and salts from dyes are quite feasible. K. S. Campbell

Oxidation of Cotton

Action of NaClO solutions on cotton in presence of reduced vat dyes. S. H. Mhatre and G. M. Nabar. *Current Sci.* **13**, 256–7 (1944) (through *Chem. Abstr.* **39**, 1761[8], Apr. 20, 1945).

Turner, Nabar, and Scholefield found (*C.A.* **29**, 7079[6]; **31**, 1622[5]) that the intensity of the hypochlorite oxidation of cotton cellulose is considerably increased when a leuco vat dye has been deposited on the cotton. They also found that the oxidation products contained 2 aldehyde groups to each acid group. With dyes such as Caledon Yellow G and Indanthrene Yellow FFRK, which are not affected by the hypochlorite, this ratio remains 2:1. With dyes such as Indanthrene Blue R and Ciba Blue 2B, which are modified by the hypochlorite, this ratio becomes 1:1.

Peanut Protein Solutions

Viscosity patterns of peanut protein solutions. Comparison with other vegetable proteins and with casein. R. S. Burnett, E. J. Roberts, and E. D. Parker. *Ind. Eng. Chem.* **37**, 276–81 (Mar. 1945).

Methods for preparing and determining the viscosity of vegetable protein solutions at useful concentrations are described. Data are presented which show the influence of concentration, heat, pH, time, and other factors on the viscosity relations of peanut protein solutions made alkaline with sodium hydroxide. These factors are, in turn, influenced by the conditions under which the peanut meal is prepared, by the methods employed in separating the protein from the meal, and by the subsequent treatment received by the separated protein. The viscosity behavior of peanut protein solutions is compared with that of solutions of casein and of soybean and cottonseed proteins. 12 references. Authors

Rubber Chemistry

Chain molecules—the production of artificial fibers, resins, and rubber. Anon. *Silk J. Rayon World* **21**, 45–6, 53 (Jan. 1945).

A brief review of recent developments in the chemistry of natural and synthetic rubbers.

E. G. Martin

Stress-Strain Curves of Paper

Stress-strain curves of paper. E. R. Gibbon. *Paper-Maker* **108**, TS53–6 (1944) (through *Chem. Abstr.* **39**, 1990², May 10, 1945).

The stretching properties of paper under tension and its recovery on release of stress were studied. The results are presented in the form of graphs, which are all of similar algebraic type, both for stretch and recovery; if superposed on one another, they show pronounced symmetry and many of the curves are practically coincident. No attempt was made to work out equations from a consideration of dynamics to correlate stretch and recovery with the many factors involved; but it was observed (without any scientific explanation being offered) that the equation $S = F(L^2 + 5L)$ (in which S is the stretch, L the load and F a factor varying for different papers) fitted the data for a number of the graphs with a moderate degree of closeness. However, it would be very difficult to determine how many variables and in what degree these variables go to make up F; and it would be almost impossible to arrive at a universal formula. It can be stated with some confidence that certain set forces come into play in the stretching and recovery of paper in a manner common to all, irrespective of furnish and machine conditions; moreover, the recovery graphs are, for the most part, near enough inversions of the rising tracks to assume an exact reversal on the stressing process. Graphs obtained by successive loadings and unloadings of the same strips of paper almost shadowed one another, with a negligible increase in permanent set. The evidence leads to the suggestion that the primary stressing, even up to a point close to rupture, is essentially a process in which the fibers are slipping over one another into positions of d., rather than a process of extension of the fibers themselves. Once the state has been reached in which permanent set has practically reached maximum value, repeated stressing is acting directly on the fibers or on the fiber bonds, and the paper behaves almost as a perfect elastic body, at least in relation to tension. Without conjecturing where the elastic limit or yield point is located, it may be assumed that it will not appear until successive stretching has actually damaged the fibers. It is suggested that a preliminary special stretching treatment of finished paper designed to eliminate most or all of the permament set might perhaps be profitable in reducing or overcoming certain printing difficulties—e.g., it might be advantageous to a printer using a cold multicolor photogravure process, and it might also find an application for certain types of foiling machines. A test on a strip of cellophane showed that this material is "dead"—i.e., has little power of recovery from stress.

FIBERS: YARNS: FABRICS: MECHANICAL PROCESSES

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Cellulose Acetate

Cellulose acetate technique—Some recent progress. W. A. Dickie. *J. Soc. Dyers and Colourists* **60**, 332–5 (Dec. 1944).

The contributions made by cellulose acetate technology to textile science are discussed, and the following recent developments in cellulose acetate technique are described: production of superfine filaments for electrical use, monofilaments for bristles, variable denier yarns, flat yarns crimped to produce the effect of lambskin, heavy work-clothes fabric for special working conditions, producing staple effects by the controlled rupturing of filament yarns, admixture of acetate to cotton to improve the crease-resistance of the latter, use as thermal insulating materials, super-strength yarns both as the acetate and as regenerated cellulose, production of "cameo" or two-sided effects in dyeing by controlled saponification, package dyeing of acetate, "solvent dyeing," coloring by means of dyes (not pigments) in the spinning solution, use of the decatizer in finishing, and acetylation of cotton for increased resistance to microbiological action.

K. S. Campbell

Felting of Wool

Observations on the theory of felting. A. J. P. Martin. *J. Soc. Dyers and Colourists* **60**, 325–8 (Dec. 1944).

The peculiar frictional properties to which wool and hair owe their ability to felt is believed to be of an evolutionary nature and traceable to a toilet function which improved the animals' chances of survival; e.g., small foreign bodies caught in the hair will tend to work to the tip end of the fibers and remove themselves because less friction is involved than in rubbing from tip to root. A structure which, like wool, shows a difference in coefficient of friction when the direction of rubbing is reversed is said to possess a "directional frictional effect" (D.F.E.). This D.F.E. cannot be explained solely upon the basis of imbrication (overlapping scale structure) of the wool but is attributed, rather, to a particular kind of molecular structure in the scale. This theory would make the possibility of production of a wool substitute which could felt seem very slight. Shorter's theory of felting involving fiber creep is extended by the stipulation that felting takes place under the influence of compression and shrinkage takes place chiefly in the direction in which compression is applied. Felting under high pressures differs essentially in mechanism from felting under low pressures as elasticity of the fiber plays an important part in the former case and none in the latter.

K. S. Campbell

Some factors contributing to the felting of wool. Milton Harris. *Am. Dyestuff Reptr.* **34**, P72–5 (Feb. 12, 1945).

The felting ability of wool is both the most desirable and undesirable single property of the wool fiber depending upon its end use. Shrinkage of wool fabrics results from (1) relaxation of the fabric and (2) the actual felting of the wool fibers, and what may affect the latter does not

necessarily affect the former. It is believed that one of the several explanations advanced for wool felting which deserves more emphasis is the tendency of wool fibers to curl under felting conditions. This is due to the distinct structural difference between the cuticle and cortex layers of the fiber; the contractile tendencies of the two layers in warm aqueous solutions is different, and a curling or bending occurs such as takes place in a bimetallic strip. The curling tendency will therefore depend upon a certain "balance of power" between the cortex and the cuticle. The action of the various shrink-resistant treatments can be explained on this basis: they may change the contractile tendency of the cuticle with respect to the cortex or vice versa so that the normal curling tendency is minimized; in some treatments, as with carroting, the difference between the two is accentuated and felting power is enhanced. Experiments performed with stretched rubber bands coated with cellulose acetate lend support to this hypothesis. The curling tendency is not the sole cause of felting but it appears to be of more importance than has been recognized in the past. K. S. Campbell

Flax Fiber Numbers and Diameters

A statistical study of the relations between flax fiber numbers and diameters and sizes of stems. Julian H. Miller, M. Gwendolyn Burton, and Troy Manning. *J. Agr. Research* **70**, 269–81 (Apr. 15, 1945).

This study of the relation of flax fiber numbers and diameters to stem sizes in Georgia-grown flax has been made with median or midsections cut from stems selected at random. The fibers in the median portion of the stem are both more uniform and more numerous than those at the top or bottom. Cross sections of 420 stems show that as the stem increases in diameter the number of fibers, the number of bundles, and the number of fibers per bundle increase. The correlation is greatest between fiber number and stem thickness. The exceptionally large stems do not exhibit the same degree of linearity of regression as those of medium or smaller diameter. A negative correlation was found between the number of fibers per square millimeter and the cross-section area of the stem. Large stems have fewer fibers per unit of area than small stems. In this case the regression is non-linear and again the calculated values for the few very large stems are not worth as much for prediction purposes as those of the rest of the population. Large stems have coarser fibers than small stems. Diameters of fibers in the 10 largest stems are nearly twice those of the 10 smallest. A comparison of Cirrus with Triumph, two fiber varieties, shows that the fiber number per unit area of cross section is practically the same in stems of equal size, but as the average diameter of Triumph is larger, the fibers per square millimeter are fewer. A comparison of fiber numbers per stem section of equal diameter of Georgia flax with published results from the Netherlands and Northern Ireland shows a reduction of about 20 percent in the former. A study of the correlation charts in this paper shows that within flax stems of equal diameter the range of fiber and bundle numbers is probably wide enough to provide a basis for single-plant selections.

Authors

Hemp Fiber

Chemical and strength differences in dew-retted hemp fiber. Lyle E. Hessler. *J. Am. Soc. Agron.* **37**, 146–55 (1945) (through *Chem. Abstr.* **39**, 1993[4], May 10, 1945).

Retted hemp fiber is composed of about 80% cellulose and lignin, while the remaining 20% or partially soluble fraction is made up of N compounds, pectic substances, pentosans, ash, and other extractable substances. Unretted hemp fiber consists of about 30% of the partially soluble fraction. When the fiber is exposed to microbiological action, it is weakened and, as a result, the breaking strength varies inversely with the length of the retting period. Exposure to the sun shortens the time of retting. Winter retting, compared with fall retting, usually results in a better color but weaker fiber. The winter-retted fiber is lower in the more soluble fractions. Fiber grown from Kentucky hemp seed had a different level of constituents and greater strength than fiber from Chilean hemp.

Pita Argentina Fiber

Fiber of "chaguar" or "pita argentina." Gregorio P. Maidana. *Rev. facultad quím. ind. agr. (Univ. nacl. litoral, Santa Fé, Argentina)* **13**, 99–125 (1944) (through *Chem. Abstr.* **39**, 2205[2] (May 20, 1945)).

Fresh leaves of *Bromelia serrs* Griseb. contain an average of 77.02% of moisture and 7.24% of air-dry fiber. Digestion of the shredded green leaves with alkaline solutions gives a white, strong fiber with little flexibility. Boiling 0.5 hr. with 1–5% potash soap followed by thorough washing and pressing yields a very white, brilliant, silky, very flexible and strong product. Breaking strength of single fibers 1.4 kg. with elongation of 3.5 mm. It is suitable for thread, twine, and sacking. The average annual yield of fiber is calculated at 2,100 kg./ha.

Protein Fibers

Chain molecules: Proteins. Anon. *Silk J. Rayon World* **21**, 29–30, 34 (Apr. 1945).

A review is given of the properties of silk, wool keratin, and casein, with special reference to their chemical constitution. Ruby K. Worner

Manufactured Protein Fibers

Vegetable proteins and synthetic fibers. David Traill. *Chemistry and Industry* **No. 8**, 58–63 (Feb. 24, 1945).

A brief discussion of protein synthetic fibers in general is given, but the chief emphasis is on "Ardil," made from peanuts. The most suitable method for the extraction of the proteins commercially is by use of dilute alkali; the protein solution is extruded in a manner

similar to that used for viscose rayon. This must then be hardened so that it will not dry in white, matted, brittle fibers which disintegrate into powder when handled. Among the effective methods are treatment of the filaments with aqueous formaldehyde, with gaseous SO_2 at elevated temperatures, or with solutions of SO_2 in organic solvents. Ardil is a cream-colored, crimped fiber with a soft, wool-like handle; it has a tensile strength of 10 kg./mm.^{2}; elongation at break is 50–100%; it attains a high degree of dimensional stability; its absorptive capacity for water is of the same order as that of wool; it does not felt in the manner common to wool and fur; used alone, it does not have high resistance to abrasion, but blends with other fibers which do not exhibit as low resistance to abrasion as might be expected. It has good thermal insulation properties, is mothproof, and shows an affinity for dyes used for other protein fibers. 30 references.

E. G. Martin

Vulcanized Fiber

Vulcanized fiber. J. Row and T. Cathro. *Can. Machinery* **56**, 68–70, 130 (1945) (through *Chem. Abstr.* **39**, 2200^2 (May 20, 1945)).

Manufacturing operations are discussed. The basis of vulcanized fiber is pure cotton fibers obtained from clean cotton rags which are made into special types of paper. This paper is then converted chemically into a new homogeneous structure. The chemicals used in this process are later removed.

Permanent Set in Fibers

The optimum conditions for setting strained animal fibers. J. R. Hind and J. R. Speakman. *J. Text. Inst.* **36**, T19–34 (Feb. 1945).

Although the chemical mechanism of permanent set is well understood, the conditions under which yarns and fabrics should be treated to obtain maximum set with minimum damage to the fibers have never been defined. Determinations of the rate of setting of stretched fibers in boiling buffer solutions, boiling water, steam, and high-temperature steam were therefore undertaken, and the damage sustained by the fibers after various times of setting in the different media was also assessed. After the rapid primary breakdown of disulfide bonds, the degree of damage first decreases as linkage rebuilding takes place, and then increases as main chain attack supervenes. In the case of buffer solutions, the time associated with minimum damage decreases with a rise of pH, but the lowest degree of damage is given by a buffer solution at pH 7.5 in 132 min., the corresponding set being 25.7 percent with fibers treated at 40 percent extension. As setting media, steam and boiling water are inferior to the buffer solution, for the times associated with minimum damage are greater—viz., 170 and 312 minutes, respectively—and the corresponding degrees of set are less—viz., 24 percent and 22 percent, respectively. High-temperature steam (excess pressure 10 lb./sq. in.) is superior to the buffer solution in giving a higher degree of set (26.4 percent) in a shorter time (60 min.) with slightly less damage. Similar results were obtained in experiments with curled mohair yarns, except that there was little choice between the four setting media as regards the extent to which the yarns were set, and the damage they sustained in the critical times of setting. In the case of buffer solutions, the optimum pH was found to be somewhat lower (pH 6.7), and the critical time correspondingly longer, with yarn than with single fibers, presumably because of the lower ratio of solution to fiber, and the adverse effect of accumulating reaction products on the yarn when the pH exceeds 7. The critical times of setting in a boiling pH 7 buffer solution, boiling water, steam, and high-temperature steam were found to be 210, 320, 186, and 112 min., respectively. Although high-temperature steam thus gives the best results with both single fibers and yarn, the maximum on the curve showing yarn strength as a function of the time of setting is so sharply defined that there would be grave danger of weakening the yarn unduly unless the necessary time of setting were correctly defined and rigidly controlled. It is unlikely, therefore, that high-temperature steam will find extended use in practice for the setting of curled mohair yarns. A pH 7 buffer solution is superior to steam and boiling water in giving more rapid set, and although the critical time of setting is rather less with steam than with the buffer solution, the set given by the buffer is greater and the degree of damage less. A boiling pH 6.7 buffer solution seems, therefore, to be the best medium for setting curled mohair yarns in practice, but the critical time of setting must not be exceeded if the high degree of set associated with minimum damage is to be realized.

Author

Fiber Structure

The structure of the primary wall of the cottonseed hair. K. Hess, W. Wergin, and H. Kiessig. *Planta* **33**, 151–60 (1942); *Chem. Abstr.* **38**, 2693 (1944). In German; abstract in English. Abstract only available (through *Bull. Inst. Paper Chem.* **15**, 323 (May, 1945)).

Based upon information gained from the study of young seed hairs, the authors propose a model for the structure of the primary wall of which the characteristic feature is the concept of ribs of cellulose pectin. These ribs are diagonal to the axis of the hair and are encased in a sheath of fat and wax. The attachment of the sheath to the rib is supposed to involve lecithin. The conclusion is drawn that the primary wall can consist of no more than a single lamella.

Viscose Preparation

Practical notes on rayon production operations. A. G. Arend. *Silk J. Rayon World* **20**, 26, 28–9 (July, 1944).

A review of some of the details of the preparation of viscose for spinning. Recent improvements in the testing of pulp for moisture content, in disintegration, crumb handling, and removal of air bubbles from the viscose solution are described.

E. G. Martin

Unshrinkability in Wool

The production of unshrinkability by cross-linkage formation in wool: Part 1—Woven fabrics. T. Barr and J. B. Speakman. *J. Soc. Dyers and Colourists* **60**, 335–40 (Dec. 1944).

It has been argued that an unshrinkable finish might be conferred on wool fibers by modifying their elastic properties instead of by the customary method of attacking the surface scale structure. In agreement with this deduction, it has already been shown that a high degree of unshrinkability may be imparted to wool by polymerizing ethylene sulfide within the fibers, but the handle of the fabric was somewhat impaired. It seemed likely that an equal degree of unshrinkability might be obtained without altering the handle of the fabric if instead of depositing polymers within the fibers their elastic properties were modified by increasing the number of cross-linkages between the peptide chains. The properties of mercuric acetate-treated and benzoquinone-treated fabrics were therefore examined. Both reagents, which are by far the most effective cross-linking agents so far discovered, were found to confer a high degree of unshrinkability on wool. There can be no doubt that these reagents bring about this result by modifying the elastic properties of the fibers and not by attacking or masking the surface scale structure. Since benzoquinone-treated wool is highly colored and mercuric acetate-treated wool is readily discolored by hydrogen sulfide, both types of unshrinkable finish are of little commercial importance, but they reveal for the first time that unshrinkability may be conferred on animal fibers by cross-linking reactions, which increase their resistance to wear and have no adverse effect on handle. Authors

Semi-combing

Semi-combing versus double carding. Anon. *Textile Weekly* **35**, 734 (Apr. 20, 1945).

A report by Platt Bros. and Co., Ltd., Oldham, England, which lists advantages of semi-combing over double carding, among which are: use of a lower grade cotton, heavier carding and thus higher production at the card, and lower waste percentage at the card. It is said that superior yarns can be produced from slightly cheaper cottons.

H. J. Burnham

Principles of Drying

Drying and driers. R. R. Clegg. *Paper-Maker* **108**, TS5–8, 25–40, 41–4 (1944) (through *Chem. Abstr.* **39**, 2014[5] (May 20, 1945)).

An outline of the fundamental principles and physical phenomena involved in drying by means of hot air, showing how the conditions involved are both applied and intensified in modern drying equipment.

New Rayon Loom

Wilson and Longbottom's new rayon and silk loom. Anon. *Silk J. Rayon World* **20**, 32, 34–5 (July, 1944).

A description of a loom designed to meet the needs of manufacturers of high-class rayon textiles and of silk. Details described are: the type and scope of the dobby; style of picking; checking, take-up and drop-box motion; reed movement; unwinding of warp; and loom driving. It is stated that the speed of the loom depends partly on the quality of the yarns used, but if they are good that the speed is 180 picks per min. The loom is driven by a cone friction clutch with pulley drive, although a geared drive may be used. The h.p. is 1.6, r.p.m. 950, and reed space 51 in. E. G. Martin

Filling Winder

The Scharer automatic filling winder. Anon. *Text. Mercury and Argus* **112**, 70, 77 (Jan. 19, 1945).

A description of the Scharer filling winder, type BNS, for cotton and wool in which a magazine arrangement is provided, of the revolver type, for supplying empty pirns as the full ones are ejected, and type SNS for silk and rayon in which the full pirns are removed by hand. The machine is said to be simple in construction, easy to operate, and to possess a maximum of safety, efficiency, and capacity for production. E. G. Martin

BLEACHING: DYEING FINISHING

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Dyeing Cellulose Fibers

Factors affecting the uniformity of dyeing of cellulose fibers. H. Hajo. *Melliand Textilber.* **24**, 511–13 (1943) (through *Chem. Abstr.* **39**, 2203[4] (May 20, 1945)).

Such factors include variations in and too high a temperature in the dye bath, inadequate circulation of liquor in the bath, presence of fiber mixtures (e.g., under equal dyeing conditions Egyptian cotton acquires a stronger shade than American cotton), and inequalities produced in a pretreatment process (e.g., bleaching, oiling, scouring, etc.) or in washing out the reagent after such treatment. In particular, HCl formed from $CaOCl_2$ bleaching residues may attack the cellulose, which then has a greater affinity for basic dyes and a lower affinity for direct dyes than has the normal fiber; oxycellulose behaves similarly. Mercerizing may set up unequal tensions in the web which affect the uniformity of dyeing, and unequal distributions of dressings and of soap residues (e.g., ppt. by hard H_2O, or adsorbed on the fiber during too prolonged an interval between scouring and rinsing) act similarly. Imperfect fibers (e.g., "dead" cotton, or S inclusions in viscose) may produce patchy results, and a dyed cloth which appears satisfactory in one type of light may appear mottled in another. With cotton, the greater the fiber-dye affinity, the greater is the tendency to non-uniformity, and vice versa.

Pigments for Textiles

Pigments for the colouration of textiles. A. W. H. Barton. *J. Soc.*

Dyers and Colourists **61**, 85–6 (Apr. 1945).

Pigments are defined as those coloring matters which are insoluble in water, oil, and resinous media. They fall roughly into four classes: pigment dyes, inorganic pigments, toners, and lakes. The chemical and physical properties of each are discussed. While only the carbon blacks and the phthalocyanine blues and greens can be said to withstand all of the various chemical treatments (bleaching agents, acids, hydrosulfites, etc.) likely to be used in textile processing, products may be selected from each of the four groups which will satisfy a number of the conditions. The pigments available for coloring textiles supply a wide range of hues but are at present lacking in brightness.

Some problems in the application of pigments for the coloration of textiles. R. J. Hannay. *J. Soc. Dyers and Colourists* **61**, 88–90 (Apr. 1945).

Economic and technical difficulties with solvent solutions of resins have directed research toward methods of application from aqueous media. This has resulted in a complex emulsion technique. When aqueous emulsions are applied to textile fabrics, the emulsion is said to be immediately broken because of absorption by the cloth of the aqueous phase, leaving the non-polar or non-aqueous phase entirely on the surface. While this may be an advantage in printing, yielding sharper prints, it does not help what is probably the greatest problem in the pigment coloration of textiles—viz., lack of fastness to rubbing, particularly when wet. It is suggested that in order to improve rubbing-fastness some method which will allow both pigment and binding agent to penetrate the fibers is necessary.

K. S. Campbell

Fixation of Pigments

Fixation of pigments on textiles from aqueous media. C. Hobday. *J. Soc. Dyers and Colourists* **61**, 87–8 (Apr. 1945).

The outstanding fastness properties (particularly towards light) of a large range of pigments makes the possibility of their mechanical fixation in textiles of great interest. The water-soluble precondensates of the urea-formaldehyde and melamine formaldehyde type of thermosetting resin have been most successful in this capacity. They are frequently supplemented by the alkyd-type resins. The water-soluble forms of the formaldehyde resins are preferred to the solvent-soluble variety because of simplicity and economy of application and the better penetration of the resin, due to water-induced fiber swelling. Less fabric stiffening is produced if the resin is applied in the least complex form possible—e.g., as near the methylol stage as possible. Oil-modified alkyd resins are useful with the amino resins because they act as plasticizers (especially with the solvent-soluble type), to some degree as catalysts, and because they aid materially in dispersing any pigment. However, they impart fullness of handle and somewhat reduce wet-fastness. Adequate fixation of pigment can be obtained by as little as 5% of dimethyl ether of dimethylol urea, or 1—2.5% hexamethylol urea. Certain pigments thus fixed will withstand 2 hours' boiling in 0.5% soap solution with negligible loss in shade and no staining of white cotton. If the resin solution is of insufficient viscosity to carry the pigment, soluble gums may be incorporated. Special fine-powder qualities of pigment are necessary for good results. Methods of application and after-treatment are described. Completely satisfactory fastness to wet rubbing is said to be obtainable only with large quantities of resin applied from solvent media, in which case a more or less continuous film is formed and the natural physical characteristics of the fiber are sacrificed to some extent.

K. S. Campbell

Rayon Sizing

Animal glue in rayon sizing. H. B. Sweat. *Textile Bulletin* **68**, 24, 66–7 (May 15, 1945).

A discussion of the use of animal gelatin glue in the sizing of rayon yarns. For slashing it is recommended that the grade known by gelatin manufacturers as No. 18 be used for higher crepe soaking, No. 15 for regular crepe, No. 11 for fine deniers, No. 10 for medium deniers, and No. 9 for coarse deniers.

H. J. Burnham

Sizing Warp Yarns

Sizing of spun viscose warp yarns. I. Effect of stretch in slashing. W. E. Shinn and Paul T. Biggers. TEXTILE RESEARCH **15**, 15–19 (Jan. 1945).

A series of slashing tests were performed in which the tensions were progressively increased to give a range of stretches varying from approximately 1% to nearly 15%. Other factors were kept constant. It was found that a warp can be made from 30/1 yarn spun from $1\frac{1}{2}$-in., $1\frac{1}{2}$-den. viscose staple and the yarn subjected to a stretch of nearly 14% between the quetch rolls and the first drying cylinder before end breakage occurs at this point. This figure approximates the total dry elongation of the unsized yarn. At 15% serious end breakage occurs on the first cylinder, because of the tendency of the warp to contract in drying. The tensile strength of the sized yarn was in no case less than that of the unsized yarn and increased with stretch up to 12%. The lowest average single strand tensile strength of 8.51 oz. per thread was recorded for yarn stretched 1%. The highest tensile strength of approximately 10 oz. per thread was recorded for yarns stretched 12%. Residual elongation at the breaking point showed a marked decrease as the stretch was raised. For each increase of 1% in stretch there was a reduction of approximately one-half of 1% in residual elongation. In weaving, the highest end breakage per thousand picks was found to coincide with the highest stretch because of cutouts at the heddles. These cutouts are caused by the passage of knots. It was found that the fabrics representing the highest stretch dyed equally as well as the fabric representing low or normal stretch, and that the finished

goods did not exhibit shiners as a result of stretching the warp. J.

Sizing of spun viscose warp yarns. II. Abrasion testing of sized warp yarns. W. E. Shinn and Paul T. Biggers. TEXTILE RESEARCH JOURNAL **15**, 19–21 (Jan. 1945).

A method is presented for measuring the abrasion resistance of sized yarns. The apparatus used is described and illustrated and the results of a number of tests in which various sizing formulas were used are given. J.

Sizing of spun viscose warp yarns. III. Application of Synthesize, a thermoplastic abietic acid ester. W. E. Shinn and Paul T. Biggers. TEXTILE RESEARCH JOURNAL **15**, 37–40 (Feb. 1945).

The application of Synthesize was investigated. The ester was modified with a non-drying oil and emulsified with an amine soap. The addition of the emulsion to the size did not improve the breaking strength of the yarn but did decrease the abrasion resistance of the warp. The residual elongation of the yarn was increased and the shedding of fiber from the warp in weaving was reduced. Also the loom stops were reduced. Some deterioration of the fiber, due to the presence of the sizing material, was noted. J.

Sizing of spun viscose warp yarns. IV. Application of methyl cellulose, a water-soluble plastic, in spun viscose warp sizing. W. E. Shinn and Paul T. Biggers. TEXTILE RESEARCH JOURNAL **15**, 40–5 (Feb. 1945).

A study was made of the use of methyl cellulose as a thickener for sizing and finishing pastes. It was determined that the percentage of methyl cellulose used in a sizing formula must of necessity be small or low size-box temperatures must be used. A wide difference in abrasion resistance was observed between warps sized with methyl cellulose alone and those sized with different percentages of methyl cellulose and corn gum. It is shown, however, that it is possible to weave yarns sized with methyl cellulose alone and yield high abrasion resistance and flexibility of the warp yarn. J.

Sizing of spun viscose warp yarns. V. Application of corn starch ether gum in spun viscose warp sizing and its removal from fabric. W. E. Shinn and Paul T. Biggers. TEXTILE RESEARCH JOURNAL **15**, 78–81 (Mar. 1945).

A corn starch ether gum was studied to determine its suitability for use in sizing spun viscose warps. The product was found to be soluble in cold water and the films formed from it were also soluble in cold water. Highly viscous size pastes were produced with a relatively low solids concentration. Satisfactory abrasion resistance and weaving quality resulted from use of the gum, but considerable shedding of fiber resulted in weaving. Fabric stiffness was observed to be approximately the same as that produced by corn gums with low solubilities. Considerable advantage is indicated in finishing and dyeing because of the ease of removal of the size from the fabric. Complete removal of the size from the fabric could not be effected with cold water, but hot water and soap were found to produce satisfactory desizing. Direct dyes were used to dye the fabric in both a sized and a desized condition. It was found that satisfactory dyeing was possible with no preliminary desizing operation. Dyeing and desizing were effected simultaneously and the colors so produced were fully equal to those produced on fabrics desized by hot water and soap and by a bacterial enzyme. J.

Synthetic Textiles

The case for synthetic textiles—Part III. Anon. *Modern Plastics* **22**, 95–101, 204, 206, 208, 210 (March, 1945); *cf. B.I.P.C.* **15**, 262 (through *Bull. Inst. Paper Chem.* **15**, 350 (May, 1945)).

The third of the article deals with plastic finishes of textiles, including a discussion of developments in water-repellent finishes, wool that will not shrink, plastics in printing and dyeing, crease-resistant fabrics, and resin finishes to create special effects. Parts I and II were abstracted in TEXTILE RESEARCH **14**, 440 (1944).

MISCELLANEOUS

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Air-Conditioning

Evaporative-cooling primer for textiles. H. M. Irons. *Textile Bulletin* **68**, 26, 28, 30, 50–1 (June 15, 1945).

A comprehensive article covering the fundamentals of both "direct" and "indirect" cooling systems. A sample data-sheet form is presented for estimating internal heat load in a mill, which is the prime factor in determining the size of the equipment to handle a cooling job. The heat gains are grouped into 3 types: generated, conducted, and solar. Attention is called to the fact that many "direct" systems now in use can be more fully utilized for evaporative cooling by installing controlled fresh-air supply, increasing present evaporative capacity to allow full use of "natural ventilation," and checking present humidity controls. H. J. Burnham

Color Reproduction

Design of a printed spectrum. David L. MacAdam. *J. Opt. Soc. Amer.* **35**, 293–6 (1945).

This paper gives a brief account of the design and characteristics of color reproductions such as that of the solar spectrum reproduced 19 inches long in the July 3, 1944, issue of *Life*. D. N.

Color-Blindness

A simple form of the Nagel anomaloscope. J. H. Shaxby. *J. Sci. Instruments* **22**, 15–16 (Jan. 1945) (through *Bull. Inst. Paper Chem.* **15**, 272, Apr. 1945).

Two forms—a laboratory and a pocket type—of a simplified anomaloscope are described. The scattering of light by a turbid medium is used to obtain the mixture of two

colors required to match a given color. Light is passed through juxtaposed colored filters to fall on a slab of Diffusalyte glass (transparent glass made by Chance Bros. & Co., Ltd.), the scattered mixed light emerging from the edge of the slab. A second slab is similarly illuminated by the light of the color to be matched, and the two adjacent fields varied by suitable slides, the first in color, the second in brightness, until they match.

Electronics

Electronics—and the textile industry. A. P. Mansfield. *Cotton* **109**, 97–100 (Apr. 1945).

An elementary description is given of some applications of electronics to the textile industry, including Thy-mo-trol drive, constant tension warper drive, weft straightening in a tenter, improvements of cloth printing, and electrocoating of fabrics. H. J. Burnham

Hydrogen Peroxide

Hydrogen peroxide and related compounds in industry. V. W. Slater. *Chemistry and Industry* **No. 6**, 42–6 (Feb. 10, 1945).

A survey including an explanation of nomenclature; the five principal methods of manufacture of H_2O_2 with a detailed description of the ammonium persulfate process to illustrate the general principles involved; and an explanation of the terminology used in indicating H_2O_2 strength; its properties and uses. The peroxy- compounds have entered large-scale production and application thus providing a supply of active O_2 under controlled conditions for a large variety of uses.
E. G. Martin

Laminates

Low-pressure laminates form high-strength structures. Anon. *Plastics* (Chicago) **2**, 80, 82, 116 (Apr. 1945).

A new high-strength laminate developed by Consolidated Vultee is described. "Unidirectional" fabrics of either Fiberglas or Fortisan are used as reinforcement and the resin is a mixture of a thermosetting with a thermoplastic. Details are given for the preparation of the laminate. Among the remarkable physical properties claimed are: 120,000 p.s.i. tensile, 56,000 p.s.i. compressive, 82,000 p.s.i. bearing strength, and a modulus of elasticity of 4.7×10^6.
A. R. Martin

Motor Maintenance

Commutator maintenance. C. B. Hathaway. *Textile Bulletin* **68**, 24, 26, 28, 48 (May 1, 1945).

Practical instructions are given on the maintenance of commutators and brushes of industrial size motors, and the theory of the cause of sparking at the brushes is discussed. Means taken by motor manufacturers to keep sparking at a minimum are described, as well as measures that should be taken by maintenance men when replacing brushes or repairing motors.
H. J. Burnham

Nylon

What is nylon? (Imperial Chemical Industries Ltd.). *Indian Text. J.* **55**, 318–20 (Feb. 1945).

Press release. A summary of the properties of nylon.
Ruby K. Worner

Patent Review

Synthetic fiber production research in 1944. Anon. *Silk J. Rayon World* **21**, 41–2, 46 (Mar. 1945).

This review, based largely on American and British patents, indicates many new and improved products as results of wartime investigations.
Ruby K. Worner

Plastics Course

A practical course in plastics. Joseph O. Frank and John O. Frank. *J. Chem. Ed.* **22**, 99–101 (Feb. 1945).

An outline is given of a course presented in seven Wisconsin cities as part of the ESMWT Program of the U. S. Bureau of Education under the auspices and direction of the Extension Division of the University of Wisconsin. An annotated list of frequently used references is included. Ruby K. Worner

Pulp and Paper Production

Chemical requirements of the pulp and paper industry. R. W. Porter. *Chem. and Met. Eng.* **52**, 114–16 (Jan. 1945).

The annual production of the different types of pulp from 1935 to 1943 and the annual consumption of pulpwood, lime, sulfur, caustic soda, salt cake, chlorine, fillers, and sizes are presented in tables and discussed. E. D. Klug

Du Pont Research

Du Pont research. E. K. Bolton. *Chemistry and Industry* **No. 16**, 122–7 (Apr. 21, 1945).

An address describing the history, growth, and organization of Du Pont research: fundamental research, development of new products, and the improvement of existing processes and products. Listed as outstanding research achievements are the developments in: the dye industry, neoprene synthetic rubber, moisture-proof cellophane, ammonia and other products of high-pressure synthesis, "Duco" nitro-cellulose lacquers, and nylon.
E. G. Martin

Utility Requirements

Utility requirements in process plants. M. F. Wulfinghoff. *Southern Power and Ind.* **63**, 104–8 (1945); cf. *Chem. Abstr.* **39**, 1089^4 (through *Chem. Abstr.* **39**, 2161^7 (May 20, 1945)).

Electric power requirements in kw.-hr. per ton of product are given for a variety of inorganic and organic processes. Various sources of heat are compared as to temperature range, operating pressure, advantages and disadvantages, and various types of boilers are compared. Factors involved in the choice of process heat source are discussed, and brief reference is made to generation of steam by means of waste heat.